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The Cobble Mountain Water Project of Springfield, Mass.

Construction Features of New $4,000,000 Water Supply Development of Springfield, Mass., Which Includes the Building of the Highest Hydraulic Fill Dam in the World

By JAMES B. PORTER

Assistant Chief Engineer, Water Department, Springfield, Mass.

SOME 25 years ago, the city of Springfield, Mass., selected the Little River as the source for its water supply and in 1908 and 1909 a system was constructed. This system included a storage reservoir at Borden Brook of 2,500,000,000 gal. capacity, a diversion dam on the Little River some five miles below the reservoir, a tunnel 6 ft. 3 in. by 5 ft. some 4,500 ft. long through the mountain to the filter beds, a sedimentation basin with a capacity of about 40,000,000 gal., about three acres of slow sand filters, about 7½ miles of 42-in. lockbar pipe from the filters to a pure water reservoir at Provin Mountain which has a capacity of about 17,000,000 gal., about 4½ miles of 42-in. lockbar pipe from this reservoir to the Connecticut River and two 30-in. lockbar pipes across the river. At this time the system was designed to carry the city for 25 or 30 years, but studies were made for the ultimate development of the watershed and a tentative location selected for the Cobble Mountain Dam.

Hydraulic Giants Operating in Borrow

Mud and Water Lines at 1930 Borrow; Cobble Mountain in Background

Springfield has a population of about 150,000 and supplies water to several of the neighboring towns. The total population furnished water from this supply in whole or in part is about 250,000 and the average daily use about 18 M.G.D.

General Features of New Supply.—In 1924 construction was started on enlargement of the system and in the fall of that year Mr. H. H. Hatch was engaged to make the preliminary surveys for the dam and reservoir. He has been at work since that time on the surveys and the construction of the several works embraced in the complete project.

The dam and reservoir are situated on the Little River about 20 miles west of Springfield in a rough, mountainous section. The water shed is steep and impervious without much ground storage. Nearly 70 per cent of the yearly run off takes place in a few weeks each year. The catchment area is about 46 square miles with a mean annual rainfall of 48 in. and an average run off

General View, Looking East, of Dam Site of Cobble Mountain Hydraulic Fill Dam

at the dam site of about 58 M.G.D., which will probably suffice for the needs of Springfield for the next 50 years.

The cost of the Cobble Mountain project for water supply alone would have been about $4,000,000. This with the amount already invested would have made a rather heavy burden for the city, but the location of the new dam made possible a power development at an additional cost of some $2,000,000. The Cobble Mountain Reservoir will have a flow line at Elevation 952 and it was found feasible to develop a maximum head of 450 ft. at a distance of about 1½ miles down stream. A contract was made with the Turners Falls Power & Electric Co. to take this power at an annual rental of $270,000 for 30 years. With this annual rental to help pay interest and sinking fund charges, the project became feasible and the city was able to develop this watershed to its full capacity for water supply and at the end of the thirty years own the power station also. The power company will use this plant as an auxiliary for its entire system during peak loads and during the dry seasons and for some time be able to avoid the use of their present auxiliary steam plants.

What the Cobble Mountain Project Comprises.—The Cobble Mountain project includes a diversion tunnel, the dam, reservoir, spillway, two gate houses, the power tunnel, three penstock lines with surge tank, the power house and seven highways. The reservoir will have a capacity of 22.5 billion gallons, has an area of 1,120 acres, a maximum depth of 207 ft. and an average depth of 58 ft. The length of the flow line with the reservoir full is about 20 miles. For several years the city has been acquiring land for the reservoir site and on the watershed adjoining it and nows owns about 11,000 acres on the watershed.

The site of the dam in the narrow gorge of the Little River on the north slope of Cobble Mountain is ideal. Within the limits of the dam and near its upper toe the gorge makes nearly a right angle bend. The bottom and both sides are on solid ledge of mica schist, a characteristic rock of this section.

The dam site was inaccessible, so the first step in the project was the construction of a road about three miles long northerly from the dam site to the State highway. This was built with city forces by the division engineer during the time the preliminary surveys and investigations were being made for the whole project. When the project is completed, this road will be finished, extended across the top of the dam and be connected to other highways. Several other highways which will be flooded have been or are to be relocated and built at a cost of about $350,000.

The Diversion Tunnel.—After this first highway was built, a contract was let by the city to Coleman Bros. of Boston, Mass., for the construction of the diversion tunnel and the diversion dam. The diversion tunnel will take care of the river flow during construction. It is horse-shoe shaped with an area equivalent to that of a circle of 12 ft. diameter and was designed to carry 4,000 second feet. It is about 1,600 ft. long and has a shaft near its upper end over 200 ft. deep. Both shaft and tunnel are lined with concrete and were grouted to insure against any possibility of leakage. They are both entirely in solid ledge. After the main dam is completed, the upper end of the tunnel will be plugged with concrete through which will be laid two 42-in. pipes with gates. These pipes will have a capacity of about 1,000 second feet and will be opened in case of extreme floods or when the power company has drawn the water down to the elevation of the power tunnel. The elevation of the diversion tunnel is 754 and that of the power tunnel is 830. This leaves about 1½ million gallons of water below the power tunnel which will insure the ability of the city to carry over a long dry period after the power company has drawn all the water possible for power purposes.

The cost of this tunnel was about $330,000.

The Diversion Dam.—The diversion dam is located about 1,000 ft. downstream from the diversion tunnel. It is about 75 ft. high, 240 ft. long on top and 70 ft. long at the base. It has a top width of 40 ft. and a bottom width of about 300 ft. It was built of muck from the diversion tunnel as far as was possible. The upstream face of this

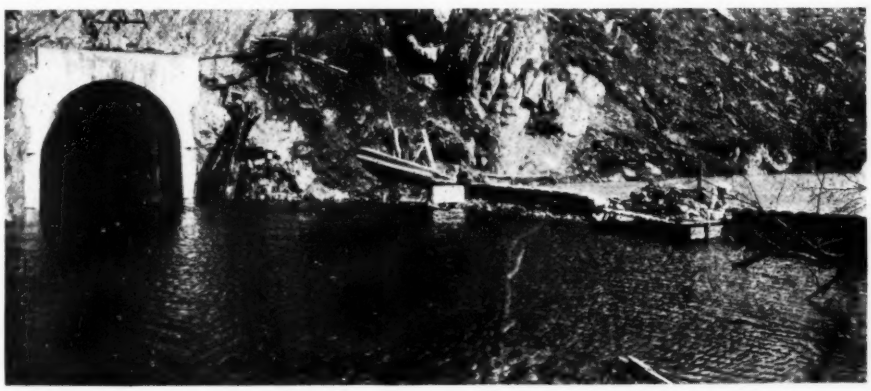
General View to Northeast Showing Core Pool, East Beach, Rock Fill, Concrete Toe Dam, Mud and Water Lines and 1930 Borrow Near Top

dam is of rolled embankment 10 ft. thick at the top and about 25 ft. thick at the bottom. This was designed to stop the leakage through the rock fill during the construction of the main dam. This dam was so located that it will form the upstream toe of the main dam and its top will be a berm on the upper face of the main dam. The total cost of the structure was about $60,000.

The Cobble Mountain Dam.—When the diversion dam and tunnel were about completed, the city received bids for the main dam and reservoir and the power tunnel. The contract for the dam, etc., was let to the Winston Co. of Kingston, N. Y., and the power tunnel to the Frazier-Davis Co. of St. Louis, Mo.

The Cobble Mountain Dam when completed will be the highest hydraulic fill dam in the world. It will have a maximum height of over 255 ft. from the bottom of the cut off wall trench and a height of 235 ft. in the center above the original stream bed. It will be 50 ft. wide at the top and over 1,500 ft. wide at the base, 700 ft. long on top and only 80 ft. long at the bottom. Due to the narrowness of the gorge and the very steep side slopes, it will contain only 1,800,000 cu. yd. of material, of which about 400,000 cu. yd. will be rock.

Site of Spillway Looking East from Near Where Spillway Bridge Will Be Located



Inlet to Diversion Tunnel

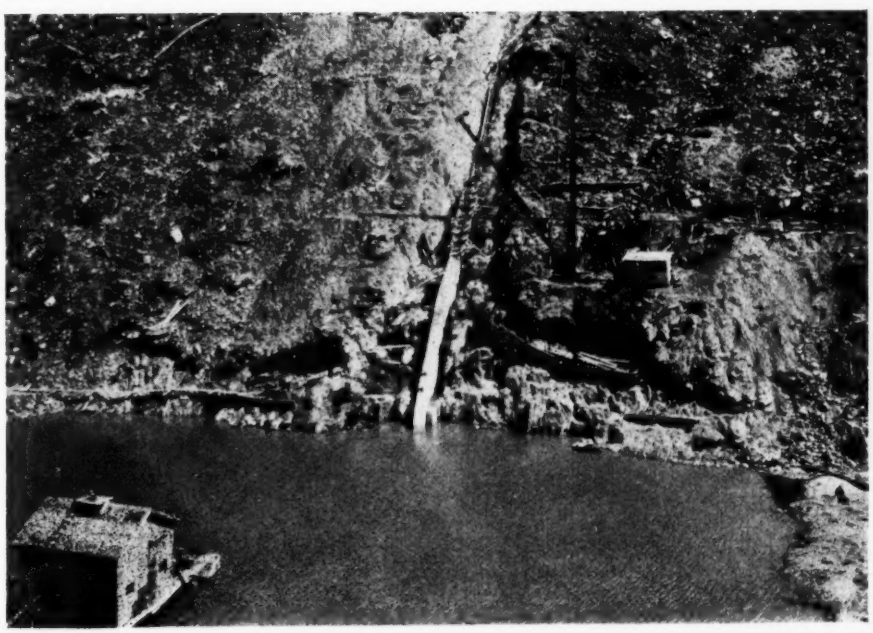
Before the contract for the dam was let, test tunnels were driven at right angles to the stream on both sides of it for a distance of about 80 ft. on one side and about 40 ft. on the other. These were driven near the center line of the dam to make certain of the character of the foundation rock.

In the bottom of the dam at the core section for a width of 270 ft. all material was excavated to the solid ledge, in some places to a depth of 15 ft. below the stream bed; also on each slope an area varying in width from 80 ft. at the bottom to 20 ft. near the top was similarly excavated.

In the bottom of the dam is a concrete cut-off wall 3x8 ft. which extends up both slopes to a point above the flow line. This was built in a trench in the ledge which is at least 5 ft. at every point below the surface of the rock. A second cut-off wall of the same dimension built into the rock in the same manner extends across the bottom and to a height of about 40 ft. up each slope.

Grout pipes are left in the cut-off walls and the rock will be thoroughly grouted before the fill reaches them. In the bottom of the dam these grout holes were 15 ft. deep and spaced 10 ft. apart all along the cut-off walls, which are 30 ft. apart. The depth of the holes was measured from the bottom of the foundation trench.

Concrete Dam at Downstream Toe.—In the original design of the dam there was not much rock in the lower toe and a concrete arch dam was designed to hold it and also to prevent erosion at



View Looking South Across Core Pool; Shows Cutoff Wall and Trench

any time by the water from the diversion tunnel which empties into the stream near this dam. Considerably more rock has been added to the lower toe, so that this dam has lost some of its importance, but it was decided to leave it as further assurance of the stability of the whole structure.

This dam is a concrete arch of about 100-ft. radius with a width of 14 ft. on top. The upstream face is vertical and the downstream face is battered ¼ to 1. The height above the river bed is 35 ft. The foundation without batter was carried down about 15 ft. below the stream bed to solid ledge. The length is about 200 ft. and the total yardage about 3,800. Its foundation is solid ledge, but is not grouted. There are three weep holes, each 4x6 ft. in the bottom to take the drainage from the lower rock fill, which has a considerable area and hence quite a run-off. The total cost of this structure was about $75,000.

Rock Fill.—Hydraulic fill dams require great care in their construction. The core which will ultimately act as the real water stop requires special care until it becomes thoroughly solidified. Some cores have taken years to solidify, but eventually have solidified into almost an artificial rock. During its semi-liquid condition the core exerts an hydrostatic pressure which on account of its heavier specific gravity will be greater than that of water. Therefore it requires support until it drains out and becomes a solid. The supports for the core are the beaches, which in turn are supported by the rock fills, which also add greatly to the weight of the body of the dam and increase its resistance after construction. In the Cobble Mountain dam there will be about 400,000 cu. yd. of rock fill or about 22 per cent of its volume. These rock fills occupy about 36 per cent of the area of the base.

Rock for these fills was obtained from several sources—from the excavation from the cut-off trenches, from the slopes, some 40,000 yd. from the spillway excavation, etc., but there were some 200,000 yd. left to borrow.

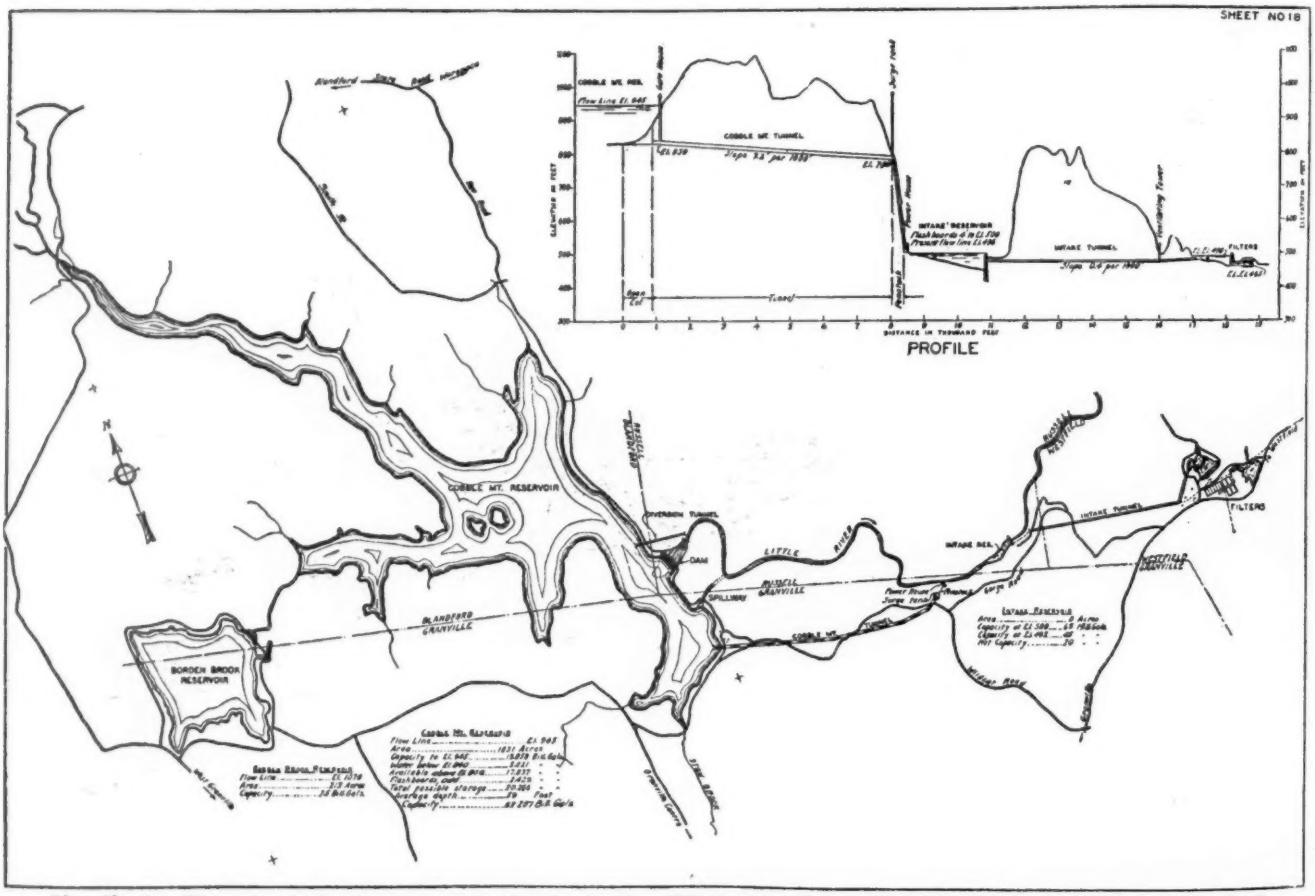
Quarries were established above the dam on both sides, the hills tunneled and shot. Much of the rock being blown into the location of the rock fills did not have to be rehandled. Seven tunnels were driven with an aggregate length of 1,012 ft.

The Hydraulic Fill.—The contractor originally figured on building the dam by the semi-hydraulic fill method, but changed to hydraulic fill before sluicing started.

The hydraulic fill was started last fall, but early cold weather made a shut-down necessary soon after the start and only 125,000 yd. were placed. However, this gave considerable information as to what additional equipment would be necessary to complete the fill in the 1930 season. This additional equipment has been bought and work for the season is now in full swing.

As the dam is being built on the stream which supplies the water to the city only about four miles above the filters and some paper mills are located a few miles below on the same stream, the contractor cannot waste the water from the pool into the stream. This waste would be the muddy water containing very fine particles which would plug the city filters and greatly increase the cost of operation and possibly make operation impossible with the present filter area and also it would make impossible the use of the water by the paper mills and involve the city in expensive lawsuits. So the contractor must use the water in the pool over and over again. To do this a second pool has been made extending from just below the diversion tunnel to the upper toe of the main dam. Stow Brook, one of the tributaries of the Little River, empties into this pool and will probably furnish enough water to take care of the loss by evaporation and the seepage through the lower toe of the dam. If this is not sufficient, additional water will be secured from the main stream.

To the spectator the operation at the dam is very simple. The rock is handled into place with shovels and trucks. Material from the beaches is placed against the rock fill with drag lines; a floating pump pumps the water out



Plan Showing Water Supply Developments of Springfield As They Will Be After Present Work Now Under Construction is Completed

View Looking East at Penstocks and Power House

of the pool, keeping it at the required level; another pump pumps the water to the giants in the borrows; the stream from the giants is directed against the bank and the material washed into the sluice pipes; the outlet of the sluice pipes is changed to get the fill where desired; shear boards prevent the washing of channels in the beaches and the water finds its way to the pool to be pumped out again and again sent over the same course.

As the flow from the sluice pipes runs down the beaches the coarse material drops first and then the next coarser and so on. When the flow strikes the edge of the pool the larger particles still suspended in the water immediately sink and only the very fine ones remain suspended. At this point the riffle forms and the core limits begin, so the water in the pool must be kept at the proper elevation and the core built as designed.

The borrow pit used last fall was only about 800 to 1,000 ft. above the upper toe of the dam. On account of the large number of boulders it proved too shallow to work and a new borrow pit downstream from the dam and to the north of the river has been opened up this spring.

The material is excavated by giants having 5-in. nozzles under a nozzle pressure of about 100 lb. It then runs down to a head box which is fitted with a grizzly and there taken into the mud line which runs to the dam.

The Spillway.—The spillway is located in a natural gorge on the opposite side of Cobble Mountain from the dam. It is nearly parallel to the stream bed in the dam, about 240 ft. above it and about 1,400 ft. southerly. It has ample capacity. The highest known flood on the Little River was about 130 second feet per square mile of water shed and the spillway will care for over 400 second feet per square mile of watershed. A model—50 to 1—of the spillway as originally designed was made at the field office and some changes made to give the maximum discharge. Three models were built and the last one checked the computed discharge. With this large capacity and a 20-ft. free board on the dam there can never be danger of the dam overtopping.

The crest of the spillway is Elevation 945. Its width is 135 ft. at the mouth, narrowing down to 50 ft. in 200 ft. with a drop there of about 17 ft. From this point on the slope is 1 per cent to the end of the spillway channel with a uniform width of 50 ft. at the bottom and ¼ to 1 side slopes. The channel from the crest to the end is about 720 ft. and it ends about 260 ft. above the river bed at a point about 3,000 ft. below the concrete dam at the lower toe of the main dam. The maximum cut in the spillway was 55 ft. and the rock excavation about 56,000 cu. yd.

A reinforced concrete arch bridge will be built over the spillway which will carry the same highway that goes over the top of the dam.

The contract price of the dam, reservoir, etc., was $1,437,000.

The Laboratory.—The laboratory which has been established at the engineer's camp is probably the most complete of any ever established on the site of a job. It includes cement testing apparatus and also apparatus for analyzing the materials in the core.

The specifications for the core require that 10 per cent must be under 0.01 mm. No sieve for these sizes is practicable nor are any made. A method for core analysis has been perfected which gives a satisfactory degree of accuracy in determining sizes of such small diameter. The analysis down to the 200 mesh sieve is carried on after the usual method and from there on the principle of elutriation based on Stoke's Law is used. The sizes are computed and the results checked by microscopic examination.

Other tests for turbidity, settling, percolation, capillary, etc., are also made.

The Power Tunnel.—The power tunnel is being built by the Frazier-Davis Co. of St. Louis, Mo. It is horse shoe shape in section 9 ft. 4 in. high by 10 ft. wide and is about 7,100 ft. long. It will be lined throughout with concrete and grouted. Its purpose is to carry the water through the mountain to the penstocks which lead to the power house. The contract price for the tunnel is $651,000.

Sluicing Onto East Beach

The Surge Tank and Penstock Lines.—At the lower end of the power tunnel a surge tank will be erected. It is to be 25 ft. diameter and about 225 ft. high. Under it the pipe from the power tunnel will be divided in a mainfold into two 8-ft. and one 6-ft. steel penstocks which will carry the water to the power house at the upper end of the diversion dam basin. The steel work for the surge tank and penstock lines is being erected by the Walsh Holyoke Steam Boiler Works of Holyoke, Mass., under a contract with the Turners Falls Power & Electric Co. The penstocks are flange steel with longitudinal seams welded with a G. E. arc welding machine and the round-abouts are riveted.

The Power House.—The power house, which is the last unit of the entire project, is being built by Daniel O'Connell's Sons of Holyoke, Mass., under contract with the Turners Falls Power & Electric Co. It is of brick. It will have a capacity of about 33,000 kva. under an average head of 420 ft. The maximum head will be 450 ft. and the minimum head 330 ft. In it will be installed two 13,650 kw. and one 5,750 kw. units. Its estimated cost, together with the surge tank and penstocks, is $1,100,000. Its average annual output is estimated to be 22,000,000 kw. hour which will be transmitted to Westfield at 66,000 v. and then delivered to the company's system. It will add 23,000 kw. of capacity to their system.

Personnel.—The entire Cobble Mountain project with the exception of the surge tank, penstocks and power house is being built by the Board of Water Commissioners of the City of Springfield, Mass. Mr. E. E. Lochridge is Chief Engineer, Hazen and Everett are the Consulting Engineers and Mr. H. H. Hatch has been the Division Engineer in charge of all the preliminary and construction work. The surge tank, penstock lines and the power house are being built by the Turners Falls Power & Electric Co. under contract with the city. On their work Mr. H. M. Turner of Boston is the Consulting Engineer and Mr. H. A. Moody, Hydraulic Engineer for the company, has charge of the construction.

Filtration Plant Operations at St. Paul, Minn.

Some interesting information on the operation of the water works of St. Paul, Minn., in 1929 is given in the recently issued report of the Board of Water Commissioners, of which Leonard N. Thompson is general superintendent and engineer. The following notes on the operation of the water purification works are extracted from the report.

The year 1929 witnessed the peak of water treated and purified since the plant has been in operation. The maximum month was August, with a total of 873 millions, while the minimum month was February, with 591 millions of gallons. The volume of water for the month of August exceeded that of February by 8 per cent, when reduced to months of equal length, 34 per cent.

Table I—Comparison of Average Analyses of Water from the River, Plant Influent and Plant Effluent

Determination	Mississippi River p.p.m.	Plant Influent p.p.m.	Plant Effluent p.p.m.	Storage in Lakes Percentage Gain	Storage in Lakes Percentage Loss	Storage and Treatment in Plant Percentage Gain	Storage and Treatment in Plant Percentage Loss
Temperature C	11.5	10.7	11.1	.....	6.95	.....	3.48
Turbidity	7.2	5.8	0.0	.....	19.50	.....	100.00
Color	34.1	33.7	12.1	.....	17.70	.....	64.5
Odor at 90 C	2.84	2.74	0.48	.....	3.52	.....	83.2
Ammonia Nitrogen—N	0.0767	0.0629	0.0646	.....	18.00	.....	15.8
Albuminoid Ammonia—N	0.0215	0.0267	0.0170	24.2	.....	.....	15.8
Nitrite Nitrogen—N	0.004	0.002	0.001	.....	50.0	.....	75.0
Nitrate Nitrogen—N	0.089	0.090	0.068	3.4	.....	.....	23.6
Oxygen Consumed	10.8	10.9	8.1	0.9	.....	.....	25.0
"H"ion—pH	7.23	7.23	6.94	.....	.....	.....	4.0
Alkalinity—Phenolphthalein	3.50	4.2	.....	20.0	.....	.....	100.0
Alkalinity—Methyl Orange	153.0	139.0	126.0	.....	9.2	.....	17.7
Free Carbon Dioxide	0.92	0.04	2.84	.....	95.7	209.0	.....
Dissolved Oxygen	9.08	9.93	9.38	9.36	.....	3.3	.....
Residue on Evaporation 110 C.	206.0	179.0	187.0	.....	13.2	.....	9.2
Loss on Ignition	89.5	88.4	81.9	.....	1.23	.....	8.5
Non-Volatile Salts	116.0	96.0	105.0	.....	17.7	.....	9.7
Silicon Oxide	6.12	2.90	2.12	.....	52.3	.....	65.4
Iron Oxide—Fe_2O_3	0.654	0.240	0.126	.....	62.7	.....	80.8
Aluminium Oxide—Al_2O_3	1.346	1.127	1.133	.....	16.28	.....	15.85
Chlorine—NaCl	2.44	2.29	3.68	.....	6.15	50.80	.....
Calcium Carbonate—$CaCO_3$	90.0	89.0	89.0	.....	1.45	.....	1.11
Magnesium Carbonate—$MgCO_3$	49.0	48.0	47.0	.....	3.25	.....	4.47
Sulphur—$CaSO_4$	13.22	13.00	27.30	.....	1.67	106.0	.....
Manganese—Mn	0.098	0.053	.....	.....	46.9	.....	100.0
Temporary Hardness	135.0	132.0	117.0	.....	2.37	.....	13.3
Permanent Hardness	13.3	12.9	27.2	.....	3.0	105.0	.....
Total Hardness	149.0	145.0	144.0	.....	2.49	.....	3.2

The water used for backwashing the filters increased 37 per cent over water used for the same purpose, year of 1928. The increase may be attributed to two things: First, the mechanical condition of the plant; and, second, the condition of the plant influent as influenced by the presence of micro-organisms. The weather conditions were of such nature this year that the micro-organisms flourished for a long period both in the spring and in the autumn seasons.

The aluminum sulphate has been reduced 1¼ per cent compared to 1928, and 48.3 per cent compared to 1927. The total application for the year 1929 averaged 20.69 parts per million.

The average dosage of liquid chlorine increased 7 per cent for the year as compared to 1928.

Table I is a summary of all chemical data. The data show the relation between the chemical analysis of the water as taken from the Mississippi River, plant influent, and plant effluent. Columns 4 and 5 of the table show the percentage gain or loss effected by storage in the lakes, and by storage in the lakes plus water purification treatment. In general the products dissolved in the water are reduced by travel through the lake system, and by water purification treatment. In some few cases the data show a gain in dissolved material by traveling from the river through the lakes or by purification treatment. Albuminoid ammonia nitrogen increased 24 per cent during travel through the lake system. The material is probably contributed by decomposition of organic material such as weeds, and other debris in the lake.

Nitrate nitrogen gained 3.4 per cent. Oxygen consumed or oxygen consuming power of the water increased slightly during the passage of the water through the lake system. The oxygen consuming power is a crude measurement of the less readily digestible carbohydrates—refuse from plants. The weed growth in the lakes likely contributes the material to keep this factor on the increase as the water passes through the lake system.

The chlorine content of the plant effluent shows an increase of 51 per cent over that of the river. The increase is due to the liquid chlorine applied to the water for the purpose of sterilization.

Phenolphthalein alkalinity shows a gain of 20 per cent in the plant influent over that of the river water. Phenolphthalein alkalinity is increased in the lakes by the activity of the algae. The algae in process of growth extract the carbon dioxide from the bicarbonates of the water, leaving normal carbonates (phenolphthalein alkalinity).

Free carbon dioxide increased 209 per cent in the purified and treated water. The increase is due to the reaction of the aluminum sulphate with the bicarbonates liberating free carbonic acid.

Sulphur increased 106 per cent in the plant effluent compared to water as taken from the river. The increase is due to the sulphur added to the water in the form of aluminium sulphate. The aluminium changes to a "floc" and is removed, but the sulphur as sulphate ties up with the calcium and remains in the water.

Securing Suggestions for Bettering Public Service.—The city manager of Cincinnati enclosed with each water bill recently mailed to citizens a postcard asking for suggestions as to how to better the public service. Several thousands of them were returned with helpful replies.

FILTRATION PLANTS

A Section Dealing with Their Design, Construction and Operation

Conducted by JOHN R. BAYLIS, Associate Editor
Filtration Engineer, Bureau of Engineering, Chicago, Ill.

Water Purification Problems Discussed at the St. Louis Convention of the American Water Works Association

THE Fiftieth Annual Convention of the American Water Works Association, which was held at the New Hotel Jefferson in St. Louis June 2nd to 6th, was a very successful one. If judged by the number of excellent papers and discussions which were presented, it was the best convention ever held by the Association.

The Water Purification Division, formerly the Chemical and Bacteriological Section, presented a program of unusual interest. This division had its origin in 1913 as a section of the association, and while its activities were somewhat suppressed by the association for a few years, it began its rapid growth about 1920. Since that date no specialized group of any professional organization has grown in importance more rapidly. As though it was a great research institution for studying water purification problems, it has become the means by which most of the information worked out by those engaged in the design or operation of water purification plants becomes public and the knowledge transmitted from one to another. The groups of two, three or more who gather together in the lobby of the hotel, in the exhibition booths, or at other convenient points to discuss various problems connected with their work are probably of equal importance to the scheduled papers and discussions.

If there are those who still have doubt as to the value of the research worker in water purification, they could not have listened to the papers and discussions presented by members of the Water Purification Division at St. Louis without being impressed that research is bringing us nearer the ideal water for domestic uses. Several of the outstanding papers presented before the main sessions of the association were presented by members of the Water Purification Division. A review of some of the more important papers follows:

Committee on Standard Methods of Water Analysis.—Jack J. Hinman, Jr., Chairman, presented a lengthy report on the activities of the committee since its last meeting in June, 1929. Discussion centered largely around the inability of the committee to get favorable action by the Committee on Standard Methods of the American Public Health Association on several of its recommendations. Dr. Norton, secretary of this committee, stated one reason was that the Committee on Standard Methods of the A. W. W. A. had failed to submit specific recommendations.

Revision of Water Works Manual.—The group headed by Paul Hansen, Chicago, on revision of the chapters of the manual relating to the quality and treatment of water held a meeting June 2 and decided to recommend that a series of monographs be published at the present time instead of a revised manual. The monographs are to cover quite fully current practice in the treatment of water. At a later date the monographs may be condensed into a few chapters of a manual. A number of those present thought that the manual should be published in two volumes —one relating to sources of the water, treatment and quality; and the other to pumping stations, distribution systems, finances, etc.

The Development of Railway Water Supply Practice.—C. R. Knowles, Chicago. Presented before the Main Session. The author of this paper gave an interesting outline of the part played by the American Railway Engineering Association and the Boiler Feed Water Studies Committee in developing the treatment of railway water supplies. About one-third of the water used by the railroads in the United States is bought from the public supplies along the lines. The railroads have to use water from many sources, which makes the problem more difficult than if it was of uniform quality. Improving the quality of the water has materially increased the engine mileage on a number of railroads. J. B. Wesley, St. Louis, said the Missouri Pacific Railroad runs through nine states and uses water varying widely in characteristics. It has 89 treatment plants. C. H. Koyl, Chicago, discussed the mechanism of boiler corrosion and how it could be controlled. Now it is known that the purest iron will dissolve in the purest water. Prevent the escape of hydrogen and corrosion is prevented. Open feed water heaters that remove the dissolved oxygen so that the hydrogen will not be oxidized, and a solution sufficiently alkaline to prevent escape of hydrogen gas, prevent corrosion.

Recent Progress in the Art of Water Treatment.—Abel Wolman, Baltimore, Wellington Donaldson, New York, and Linn H. Enslow, New York. Presented before the Main Session. This paper gave an excellent resume of progress in the art of water treatment. There have been no recent changes in the basic process of water purification. An artificially constructed slow sand filter unit was put in operation in Chelsea, England, in 1829, and description of a rapid sand filter with coagulant appeared in 1885. Chlorine was used for the disinfection of water in Belgium in 1902 and in this country in 1908.

"As time progressed, the citizen demanded safety in addition to clarity. Today, these demands have been multiplied manifold so that the water works operator must supply water that is clean, that is hygienically safe, that is tasteless and odorless, that will not destroy the distribution pipes in which it flows, that will make the life of the housewife less difficult in laundry and domestic uses, and that will supply the increasingly important demands of the industrial consumer. The motto of the twentieth century is 'more and better water.'" Preammoniation, permanganization, superchlorination and activated carbon have been found effective in the prevention or control of tastes and odors. In addition to reviewing the methods for taste and odor elimination, the authors reviewed recent developments in coagulation, chlorination, correction of corrosion, water softening, iron and manganese removal, and analytical methods and laboratory control. They made available to the water works practitioner unfamiliar with technical details of

water treatment, the important advances in recent years. W. W. Brush, in discussing the paper, stated that the reason for such exacting demands from the public was that the water purification operators themselves had created the demand by supplying water of such a high quality.

The Purification of Highly Turbid Waters.—John D. Fleming, St. Louis. Presented before the Main Session. An outline of the treatment of the muddy Missouri River water at the Howard Bend Station of the St. Louis Water Division was given. The plant includes preliminary sedimentation in basins equipped with Dorr clarifiers, treatment with lime and iron, mixing in circular tanks, settling first in basins equipped with Dorr clarifiers, secondary sedimentation in plain settling basins, recarbonation, coagulation with aluminum sulfate, filtration, and chlorination. Without continuous sludge removal the basins handling the coagulated water would fill completely within about 50 days. Part of the sludge removed is returned to the presedimentation basins, materially increasing their efficiency. Flue gases from the boiler plant are used to carbonate the water. No trouble has been experienced by the use of such gases. Pipes for the removal of sludge from settling basins must have a fairly high velocity to prevent clogging.

Recent Water Borne Disease Outbreaks and Their Significance.—Abel Wolman, Baltimore, and A. E. Gorman, Newark. Presented before the Main Session. Typhoid epidemics within the past 10 years resulting from the transportation of the infectious germ by water indicate that there has been a decline in interest in and attention to safeguarding details of the problem by health officers and water works operators. If there has been a change in the typhoid epidemics, it has been in the direction of increased severity. Due to the decreased artificial and natural immunity of populations, a typhoid epidemic, when it does strike, hits heavily. The optimistic idea that typhoid is under control is erroneous. Montreal, Canada, and Hanover, Germany, have been visited in the last 10 years by the greatest recorded single typhoid epidemics in history. In Montreal, where the bacillus was milk-borne, there were approximately 5,000 typhoid cases, resulting in 260 deaths, and in Hanover, where the germ was transported in water, there were about 4,500 cases, with 380 deaths. That typhoid epidemics are not a thing of the past is demonstrated by the fact that 226 epidemics occurred within the past 10 years. Sixty-seven of these resulted from water supplies of surface origin that were untreated, 54 from underground water, 43 from failure of modern water purification devices, and 31 from mishaps after the water had left the treatment plant. Detroit had an outbreak of dysentery in 1927, due to a sudden pollution of the raw water before filtration and failure of the treatment plant to properly treat the water for a short period. The Health Department of Detroit estimated that 45,000 to 50,000 cases resulted. The trend of judicial opinion on the epidemic question is towards penalizing water works operators in dollars and cents for damages resulting from the ravages of the disease.

Private Cross Connections and Similar Menaces to Quality of the General Public Supply.—Joel I. Connelly, Chicago. Presented before the Main Session. The author called attention to the number of ways in which the water supply may be contaminated from cross connections and connections of the pipes to tanks that may become contaminated. The connections to sinks, flush toilets, etc., are frequently of such a nature that water may be sucked back into the pipes when the pressure is cut off. He advised that all connections of the water pipes be made so that water cannot get back into the system when such conditions happen. S. B. Morris said that Pasadena, Calif., had recently passed an ordinance which prohibits dangerous cross connections in plumbing work.

The papers abstracted below were presented before the Water Purification Division in three well attended sessions, in a room filled to overflowing practically all the time and so hot that coats had to be discarded. Nothing but an unusually interesting program would have attracted so large a number of listeners under such unfavorable conditions. It is hoped that the comforts of this division will be given more consideration at future conventions.

Successful Application of Superchlorination and Dechlorination for Medicinal Taste to a Well Supply, Jamaica, N. Y.—Frank E. Hale, New York. An unusual case of medicinal taste was thought to be due to oil and gasoline wastes from a garage which penetrated through the ground to the wells. The addition of a very small amount of gasoline to water and then treating with chlorine in quantities generally used for sterilization of the water produced the medicinal taste characteristic of chlorophenol. This taste could be largely eliminated by superchlorination. Superchlorinating the well supply and dechlorinating with sulfur dioxide only a short time afterwards produced satisfactory results.

Progress in Superchlorination Treatment for Taste Prevention at Toronto.—Norman J. Howard, Toronto. Superchlorination followed by dechlorination treatment of the city water for the prevention of taste was first successfully used at Toronto in 1926. At first the equipment was inadequate, but at the present time that are 10 chlorine machines and 8 sulfonators in commission. These machines have a combined capacity of 5,400 lb. daily. At first there was difficulty in maintaining adequate sulfur dioxide cylinder pressure. The sulfur dioxide is now drawn off as a liquid and discharged into 150 lb. steel cylinders immersed in a water bath. By maintaining a water temperature of 190° F., an operating pressure of 45 to 58 lb. is maintained. The sulfur dioxide is shipped in 1-ton cylinders. The opinion was expressed that ammonia present in the raw water offers little or no protection against taste conditions, but if the water is treated with quantities of applied ammonia, the taste condition can be corrected. In at least three known instances the superchlorination and sulfur dioxide treatment has proved ineffective in preventing taste. Activated carbon may be effective in removing tastes not eliminated by the superchlorination treatment. The cost of the super- and dechlorination treatment is $0.72 per million imperial gallons. Louis B. Harrison, in discussing the paper, stated that the superchlorination treatment was not successful at Bay City, Mich.

Chemical and Mechanical Utilization of Activated Carbon in Water Purification.—A. S. Behrman and H. B. Crane, Chicago. The successful use of activated carbon has been demonstrated by installations in industrial plants. In the municipal field its use to date has been confined largely to experimental units. Experiments and full scale experience have demonstrated that the proper sort of carbon may be used successfully for the removal of practically every kind of organic taste and odor, for the elimination of free chlorine, for the removal of organic coloring matter, and for the separation and removal of iron. The advantages of the carbon treatment is the purification accomplished and the ease of operation. When combined with the superchlorination treatment it automatically and accurately dechlorinates without attention from the operator. There is no accurate information as to the life of the carbon and its cost, for none has been in use long enough for the life to be determined. Not all carbons possess the proper kind of activity. An excellent gas adsorption carbon may not be a good decolorizing carbon. The decolorizing carbons appear to be the best suited for water purification. Hydrodarco is made from Texas lignite. It contains about 70 per cent carbon and weighs about 18 lb. per cubic ft. Plant layouts for the use of carbon units were illustrated. The authors also described and illustrated how existing plants could be equipped with carbon units. Paul Hansen, Chicago, stated that engineers must give consideration to the possible use of carbon in the design of future filtration plants.

The Use of Activated Carbon for the

Removal of Taste and Odor from Water.—George D. Norcom. The author gave the results of experiments with activated carbon on highly polluted water which contains objectionable tastes practically all the time. The municipal supply at Chester, Pa., is polluted by a variety of industrial wastes and sewage. Superchlorination did not prove successful in removing the tastes. A series of experiments of fairly long duration on the effectiveness of activated carbon in removing objectionable tastes were illustrated. One brand of carbon (hydrodarco) removed all tastes from the water during the several months' duration of the test. Passing stream through the carbon beds partially revivified the carbon. Robert Spurr Weston, Boston, in discussing the paper, spoke encouragingly of the use of activated carbon.

Further Observations on the Use of Activated Carbon in Removing Objectionable Tastes and Odors from Water.—John R. Baylis. This paper brings up to date the experiments on activated carbon which have been under way for two years at the Chicago Experimental Filtration Plant. A former paper published in the June, 1929, issue of the "Journal of the American Water Works Association" gave the results of the experiments up to that date. Rates of passing the water through the carbon units, depths of beds, and methods for revivification were discussed in the latter paper. Several brands of carbon show good dechlorinating properties. Of the materials tested, Hydrodarco gave the best results. It gives promise of being a very cheap means of dechlorinating water, as well as being effective in removing taste producing compounds not eliminated by superchlorination. The experiments are still under way. Charles P. Hoover, Columbus, discussed the patent situation in reference to the use of activated carbon in water treatment. W. A. Helbig, New York, stated there was evidence of a concentration of both free chlorine and organic matter on the surface of the carbon, which probably aided in the oxidation of the organic compounds. E. B. Showell, Jr., Buffalo, gave an account of the use of bone char containing about 10 per cent of carbon in removing tastes and odors from the water for drinking purposes at the Du Pont Rayon Company's plant at Buffalo. The water is highly polluted with sewage, and is prechlorinated to prevent septic action in the settling basins. The water has a residual chlorine of 0.15 to 0.35 ppm. after filtration. When tastes were noted in the water going to the carbon units, it was completely removed 54 per cent of the time, 24 per cent of the time it was slight, and the balance of the time it was bad. He did not regard passing the water through beds of bone char which had been in service several years a satisfactory solution of their taste problem, even though it dechlorinated the water.

Some Neglected Dangers to Water Quality.—Jack J. Hinman, Jr. Prof. Hinman gave an excellent discussion of some of the things frequently neglected in the protection of water against contamination. Cross connections to polluted supplies or connections to fixtures where the water can be sucked back into the pipes when the pressure is low or is off, are always a danger to the quality of the water. He related how specimen jars in a laboratory on the upper floor of a building, which had tubes leading below the water level in the jars, had contaminated the water in the building when the pressure was cut off for a short time.

Unusual Color Removal Plant for Part of the Los Angeles Water Supply.—Carl Wilson, Los Angeles. This paper, which was read by Chairman Hale, described experiments on water of an unusual nature. The water contained color as high as 125 ppm. and could be successfully coagulated only with ferric chloride. The procedure that gave the best results called for several modifications of existing filtration practice. It was found necessary to use sand of 0.9 mm. effective size and to use beds only about 10 in. thick. Returning the sludge gave added color removal. The precipitated ferric hydroxide from a given amount of water, when removed and added to an equal amount of the raw water, gave considerable decolorization. It could be used several times before it lost its power to remove some of the color. Seth G. Hess, New York, and L. L. Hedgespeth, Philadelphia, gave interesting accounts of the use of ferric chloride for treating water.

The Trial Filtration Plant, Ottawa, Canada.—George G. Nasmith, Toronto. The author gave a description of the Ottawa Experimental Filtration Plant. The plant was constructed to demonstrate that the colored Ottawa River water could be handled successfully. Chlorinated iron did not give satisfactory results. Aluminum sulfate gave good results, but it must have a fairly long period of mixing to get good settlement of the coagulated matter. The coagulated matter does not form a mat at the surface of the sand, but penetrates into the sand bed. Coagulated matter frequently passed through the sand beds before the loss of head reached the maximum. W. E. MacDonald, Ottawa, stated that good mixing was obtained by eliminating the stirrers and giving the water a spiral flow through the mixing tanks.

Prechlorination in Relation to Filter Plant Efficiency.—H. W. Streeter, Cincinnati. By prechlorination, raw water containing as many as 20,000 B. Coli per cc. could be filtered and meet the Treasury Department standard without producing objectionable chlorine tastes. This is about twice what may be handled when the water is chlorinated after filtration only.

Observations on Filter Sand Shrinkage.—W. M. Wallace, Robert Hulbert and Douglas Feben, Detroit. Increasing the rate of wash on the filter beds at the Detroit Filtration Plant materially improved the condition of the filters. The sand was first cleaned by treating with sodium hydroxide and then thoroughly washed with a hose. The rate of wash was increased as much as the washing system would allow. This gave a sand expansion slightly less than 50 per cent, the 50 per cent expansion being found to be about the ideal wash in the experimental work. The high rate of wash has prevented the sand grains from becoming heavily incrusted as they did formerly. A new theory of sand shrinkage was given. The sand grains settle loosely after washing, and when the pressure increases due to the increase in the loss of head the grains are forced together in a more compact form, causing the bed to shrink. It was shown that practically all increase in the loss of head over the initial loss took place in the top 3 or 4 in. of sand. The loss of head along the sidewalls below the sand surface, where there is shrinkage of the bed, is very little, whereas a clean bed will show a sidewall loss nearly equal to that of the center of the bed. The reason why there is very little loss where there is shrinkage is due to the sand being pushed away from the sidewall. The formation of clogged areas along the sidewalls of the filters was explained. When a clogged area starts forming the wash water is deflected from its regular course. The authors suggest that the application of more wash water near the sidewalls might be of advantage. The paper was discussed by Frank W. Herring, Chicago, and Charles R. Cox, Albany, N. Y.

Manipulation of pH at Springfield, Ill., Water Purification Plant.—Charles H. Spaulding, Springfield. Lime is applied to the water in excess, then it is recarbonated to make it chemically stable. Stack gases are used as a source of CO_2, and there has been no difficulties encountered by the use of such gases. Analyses made on the water before and after passing a hot water system showed that magnesium and silica were deposited in greater quantities than calcium.

Efficient Water Works Operation and the Purification Laboratory.—Martin E. Flentje, Harrisburg, and P. S. Wilson, New York. The authors gave interesting illustrations of how the laboratory was used as an aid to efficient and economical operation of water works systems. The operators with little or no technical training are taught how to make certain tests that are essential for the operation of the purification plants. They are equipped with stirring machines and daily tests

are made to determine the minimum quantity of coagulant that may be used. Control of corrosion produces considerable operating saving in the systems that are corrosive.

Elimination of Taste in the Water Supply of Lancaster, Pa.—Edward D. Ruth. Experiences with the use of ammonia with chlorination was described. The ammonia is fed into the water in advance of the coagulant and the chlorine after filtration. The treatment has successfully eliminated all tastes produced by chlorine. No objectionable tastes of any kind have been noted since the treatment was started. In reply to those discussing the ammonia treatment, the author stated that he has heard many favorable comments on the quality of the water since the treatment was started.

Preammoniation of the Filtered Water Supply of Cleveland, O.—J. W. Ellms. A description was given of the large plant installations of ammonia equipment for adding ammonia to the Cleveland water. Chlorophenol and other tastes due to the addition of chlorine are entirely eliminated. The chlorine is applied shortly after the ammonia. An average of 0.12 ppm. of ammonia has been used. The cost is about 30 ct. per million gallons.

The two papers on ammonia treatment attracted considerable attention. There were several written and a number of oral discussions. Howard J. Pardee, Long Island City, stated that much more work was needed to be done on the use of ammonia. Louis B. Harrison said it did not remove the objectionable tastes at Bay City, Mich. W. C. Lawrence defended its use at Cleveland and stated that it had vastly improved the quality of the water.

Efficiency of Chlorination at Chicago.—H. H. Gerstein, Chicago. Fifty thousand analyses covering a period of 5 years were used in making the study. The B. Coli in the chlorinated water increased as the B. Coli in the raw water increased. When the raw water averaged 100 B. Coli per 100 cc. the chlorinated water averaged 0.074 B. Coli per 100 cc., and when it averaged 1000 B. Coli the chlorinated water averaged 0.187. The chlorinated water averaged well under the Treasury Department standard all the time. This is due largely to the very efficient chlorine control in seeing that the water has a residual all the time. The efficiency of the chlorination dropped off as the turbidity increased. There were several discussions of the paper.

The Elimination of Coli-Aerogenes Contamination, Due to Pump Packing, from a High Pressure Centrifugal Pump.—Arthur F. Mellen, Minneapolis. An interesting case of how water may show a decided increase in B. Coli from the packing of a high pressure pump was given. B. Coli grew on the packing, and when the pump was thrown into service the water-seal pressure forced water from around the packing into the suction side of the pump. The author explained how a change in the water-seal could be made to prevent contamination. In discussing the paper, Fred O. Tonney stated that if a slight change could be made in the pump design, as indicated, this probably was the best way to overcome such troubles.

A Demonstration of Direct Counting of Coli-Aerogenes Organisms in Cyanide Citrate Agar.—Ralph E. Noble and Fred O. Tonney, Chicago. The need for a method of direct counting of organisms of the coli-aerogenes group was discussed. Plates containing the colonies of B. Coli and the aerogenes were demonstrated. Such a procedure gives a direct count of the organisms, which is desirable. It also enables the determination to be made in a much shorter time than the procedure now generally used.

American Water Works Association Membership Campaign

The A. W. W. A. Membership Drive for 500 new members in 1930 has reached the 440 mark, or 88 per cent of the quota on June 15. Several of the state sections have over-subscribed their quota, with Wisconsin leading, Central States second and New York third.

The Central States led the list at the opening of the St. Louis convention, but was passed by the Wisconsin Section, due to a number of applications brought to St. Louis by W. C. Muegge of the Wisconsin Membership Committee.

Bill Lawrence of Cleveland, who captained the Central States Membership Committee, is going out to win back first place in this campaign and it looks as if before the end of 1930, with this kind of spirit prevailing in the leading sections, the hope of Chairman A. E. Gorman to bring in 500 new members over and above normal expectancy, will be realized.

One of the surprises of this campaign is the new foreign members which have been received during the last two months, totaling 23.

Plans are now being perfected in the various state committees, to organize special membership campaigns this fall in connection with the annual meetings of the various sections.

Results of 1930 Membership Campaign, American Water Works Association, as of June 15, 1930

Section	New Members	Restored Members	Total Membership	Quota	Per Cent of Quota
GROUP NO. 1—255					
Organized Sections—					
Wisconsin	17	1	18	10	180
Central States	60	2	62	40	155
New York	74	4	78	55	142
Southeastern	34	1	35	30	117
Pacific Northwest	15	1	16	15	107
Kentucky-Tennessee	20	1	21	20	105
California	23	2	25	25	100
GROUP NO. 2—75					
Missouri Valley	25	3	28	30	93.5
Florida	9	3	12	15	80.0
Illinois	18	2	20	25	80.0
Indiana	14	1	15	20	75.0
GROUP NO. 3—75					
North Carolina	6	5	11	20	55.0
Montana	3	0	3	6	50.0
Four States	26	1	27	55	49.2
New England	11	0	11	15	44.0
Canadian	11	2	13	30	43.4
Rocky Mountain	8	0	8	20	40.0
Minnesota	2	0	2	12	16.7
GROUP NO. 4—35					
Unorganized States—					
Foreign	23	0	23	5	460.0
Nevada	1	0	1	2	50.0
Southwest (Texas, Oklahoma, Arkansas)	6	2	8	25	32.0
Virginia	3	0	3	10	30.0
Louisiana	0	0	0	5	0.0
	409	31	440	500	88.0

The National Hydraulic Laboratory

The fixed equipment for the national hydraulic laboratory to be established in the Bureau of Standards at Washington will include electrically-driven pumps for circulating the water, a large concrete water-supply basin, a concrete measuring tank, several steel weighing tanks, elevated control tanks for supplying water under several different systems for distributing this water to all parts of the laboratory and for returning it from the models under test to the supply basin. A large unobstructed floor will be provided where a number of models can be built and tested simultaneously.

Owing to the great variety of problems which will be submitted for study, the equipment of the new laboratory will be designed to furnish the greatest possible flexibility of arrangement and combination, so that it can be adopted easily to the simultaneous study of a number of different problems.

The bill authorizing the establishment was signed on May 14 by President Hoover. It provides an appropriation of $350,000.

Efficiency in Meter Reading

How This Important Matter Is Handled by One of the Largest Water Companies in This Country

By L. D. SHIVELY

Chief Meter Reader, Indianapolis Water Co., Indianapolis, Ind.

Efficient meter reading is one of the most important matters confronting a water company. In the successful operation of a company there must be efficient management, efficient engineering and efficient office operation. It is equally important that there be efficient meter reading. The difference between an efficient meter reader and an inefficient one is that one thinks about his work while the other does not. The difference between an efficient and an inefficient meter reading department is measured in thousands of dollars of revenue. How the Indianapolis Water Company secures efficiency in its meter reading is told herewith, the matter being abstracted from a paper presented by L. D. Shively before the Indiana Section of the American Water Works Association.

IN the building of an efficient meter reading department, there are many things to be considered, the first being the type of men best fitted for this work. They must possess tact, and be able to think clearly and accurately. They must be courteous, have a pleasant disposition, and keep smiling through the most trying circumstances. Although they have to help move kitchen cabinets, tables, beds, rugs, etc., from trap doors before they can enter the basement to read the meter, they must still say "Thank you" when they are through. No employe of the company meets more people than does the meter reader. In fact, he is the only employee of the company some customers ever see. When they get their bill they mail a check, and if they have a complaint they write a letter. They seldom, if ever, contact with the office. It is, therefore, highly important that the reader create the most favorable impression possible on the people with whom he comes in contact. In the minds of the majority of the customers he is the water company. He is its one and only representative.

Location of Meter.—The next matter of importance is the location of the meter. If we expect the meter readers to give the best service, we should be very particular where we set the meter. The meter must be read at frequent intervals, therefore it should not be placed behind a furnace, in a coal bin, or in a cellar that is little more than a hole in the ground. If in a meter box, we should be sure the lid of that box is slightly above ground level. We should not expect a man to keep smiling, or be efficient, if he has to crawl behind furnaces, climb over coal and ashes, or remove two or three inches of dirt from pit lids.

Routing of Readers.—Another matter of vital importance is the routing of the meters. This must be done so that a reader will not be compelled to take unnecessary steps. Our company is now completing a routing system, and our experience indicates that it measures close to 100 per cent efficient. The city was divided, as nearly as possible, into sections five squares each way. Each section was numbered in such a way that if any changes are made, such as cutting new streets, the section can be renumbered without affecting any other part of the routing system. Instead of the reader zig-ragging back and forth across the street, weaving in and out among fast traveling automobiles, etc., he goes up one side of the main street and back the other, reading the cross streets for one square by the herring-bone system.

A blue print was made of each section; the streets marked off in 20-ft. spaces, and two numbers allotted to each space. Inspectors took the blue prints out on the territory and placed the property numbers on these prints in their exact location. Although the house numbers may be changed the meter account numbers remain the same. We have been more than four years perfecting and completing this system, but our experience proves that the time was well spent. The increased efficiency of our meter readers far outweighs the expense of instituting the new routing system.

Readings Per Day.—The next question of importance is how many readings should a reader procure in a day. This would be easy to answer if all we expected of a reader was to get a reading of the meter.

A year or so ago F. C. Jordan called me into his office and asked me to read an article written by a superintendent of a southern water company, in which the superintendent praised his meter readers, and said they were undoubtedly the best in the country. According to his report the readers averaged 274 readings per day. Our quota is 180. Was the mere fact that their readers procured 274 readings per day an indication that they were efficient? Our experience indicates that a reader cannot read 274 meters per day and be efficient in all matters properly coming under his charge. He is probably just a "statement taker." There are other points to be considered that we feel are just as important as getting a reading of the meter. The trend of our thought today is that these men are water company representatives and not merely meter readers, and our system is being remodeled along that line. At the present time these representatives have six other duties, namely: (1) Packing the stuffing boxes of the meters. (2) Making investigations to determine the cause of high consumption. (3) Testing the meters to make sure they are registering all the water that passes through them. (4) Locating consumers who vacate houses supplied with water by us, without notifying us. (5) Making inspections where houses are occupied and meter sheets shows water off. (6) Making take-out and test tickets where the meter has registered a certain quantity as designated in our Standard Practice.

Packing Stuffing Boxes.—The first item, "packing stuffing boxes," is of importance to the water company, because any leak at this point is the company's loss. Also, if a leak at this point continues, the small hole in the hood where the water is supposed to escape becomes clogged, the water cannot get out and corrosion sets in in the clock gears and destroys them in a very short time. We believe that the meter reader should pack the stuffing boxes when they are leaking, as it only takes him from three to five minutes. If this work is done by the distribution department, the service man must make a special trip, making the packing of the meter more expensive, and causing an added annoyance to the consumer.

Leak Inspections.—The second item, "Making leak inspections," is of importance to the customer, and is also important to the company when viewed from the standpoint of public relations. It is our policy, although we do not consider it our duty, to help a consumer find the cause of any high consumption. This service is sometimes not properly appreciated, but we know it is appreciated by some because many have written or called at the office and expressed their thanks.

During the month of December, 1929, our meter reading department made 552 leak inspections, and the monthly average for the year was about 400. If this valuable service is to be rendered the meter reader is the logical man to perform it.

Meter Testing.—The third item, "testing meters to make sure they are registering all the water that passes through them," is the most important of all to the water company, and applies especially to the commercial and industrial meters. It is necessary that a meter reader be able to read a meter correctly, and know that the meter is registering all of the water that passes through it. Some meter readers are expert "statement takers," but unless they familiarize themselves with the different types of consumers, and learn to know how much water they should use, they cannot be classed as efficient.

The fourth item, "locating consumers who vacate houses supplied by us without notifying us," is also of great importance to the water company, and a meter reader can render invaluable service to the collection department by procuring this information.

The fifth item, "making inspections where houses are occupied and reader's sheets shows water off," is important as there is hardly a month that the readers do not find one or more properties where the water is on without the company's knowledge. A reader should also watch houses that have no city water. Sometimes a plumber installs fixtures in a house, turns the water on, but does not immediately notify the office.

Take-Out and Test Tickets.—The sixth item, "making take-out and test tickets where meter has registered a certain amount," is one that must be taken care of by the meter reader. Instead of ordering a meter out for test after it has been in service a certain number of years, we now order it out after it has registered a certain quantity of water. This does not mean that all meters will be left in until they have registered a specified amount. If at any time a reader feels that a meter is slowing down, and not registering accurately, it is his duty to order it out for testing.

Missed Meters.—The question of "missed meters" is becoming a more serious problem every day. Should we let the readers use pass keys to gain admittance to homes? We do not believe they should unless we are granted permission by the consumer. If the readers, as they go around the side of the house, will call out "Water man," loud enough to be heard in the house, but not in the next square, it will save them time in gaining admittance, and lessen the number of "missed meters." The occupant knows who is coming, and will not hesitate to let him in. On the other hand, if the reader does not call but just knocks on the door, the occupant frequently does not answer, thinking it is some agent or peddler.

We have meters in a number of homes, where both husband and wife work, and there is no one at home during the day. We have been furnished keys to many of these, so that we may have access. These keys are kept in a locked room except when the readers are using them.

Another matter that may seem rather insignificant to some readers, but is really very important, is the marking of meter locations on the readers' sheets. Especially is this true where the meter is back of a furnace, or in some unusual location. If this is done it will speed up the work of the reader, and make it much easier.

Uniformed Readers.—Two years ago our company adopted the policy of uniforming the meter readers. Frequently we are asked why we did this. There are three main reasons. In the first place it makes it easier for them to gain admittance to homes. Second, it gives the readers a neater appearance, provided he takes the proper care of his uniform. Third, it is a protection to both the company and the customer. In this day of "fake meter readers," "telephone inspectors," etc., it is important that we protect our customers as far as possible, and the uniforms serve this purpose. The cost of the uniforms, which is about 1/7 of 1 per cent per meter reading, is far overbalanced by the increased efficiency of our readers.

Credit System for Readers.—We have outlined the duties of a meter reader in addition to the reading of the meter. He should be given proper credit for this additional work. We should not expect the man who packs 10 or 12 meters, and makes a like number of inspections, to read as many meters in a day as the man who does not pack any meters or make any inspections.

A logical plan is to use a point system. Instead of so many readings per day, we should require a man to make so many points. Allow one point for each correct meter reading, one-half point for each missed meter, two points for packing a meter, two points for making a leak inspection, and one point for locating a consumer who has moved without notifying us.

When a man is employed as a meter reader by the Indianapolis Water Co., he is first taught how to read meters, and then is sent to our meter repair department for two or three weeks' training. Here he learns the construction and operation of all types and sizes of meters. We find this schooling invaluable. Also, in order to develop the meter readers to the degree of efficiency they should attain, and make them real representatives of the company, the Indianapolis Water Co. has adopted the policy of holding regular meetings of the commercial department employees, including bookkeepers, billers, contract window men, telephone operators and meter readers. At these meetings the readers are brought face to face with the problems confronting the office employees. They learn how much trouble may be caused by their mistakes of omission or commission.

We must constantly impress upon their minds that their position is one of the most important in the water company organization. They should not be just ordinary meter readers, capable only of transferring a reading from a meter dial to a reader's sheet, but they should be intelligent representatives of the water company in the homes, and business places that they visit.

Dramatize Scientific Progress

The work of engineers and scientists, generally considered prosaic and matter-of-fact, was heralded in pageantry at Hoboken, N. J., by George Pierce Baker, widely-known dramatist of the Yale University Theater, before prominent engineers from more than 16 countries attending the Fiftieth Anniversary Celebration of the American Society of Mechanical Engineers.

In what is probably the first dramatic review of the history of engineering, Dr. Baker graphically depicted crises in the careers of the men whose inventions and discoveries have resulted in the present machine age.

The young and poor George Stephenson, pleading before an august parliamentary committee for permission to build a railroad between Liverpool and Manchester, was portrayed. Amid arguments that the noise would frighten the farmers' cattle and through cries of "Fool!" and "Idiot!" the undaunted inventor predicted the day when "it will be cheaper for a workingman to travel upon a railway than to walk on foot."

Michael Faraday, finder of many laws of electricity, gave the true reason for pure research when he replied to the woman who, watching a magnetic needle revolve around a wire carrying a current of electricity, asked: "Of what use is it?"

"Madam, what is the use of a newborn child?" he countered.

Faraday was shown in the pageant refusing his friends' alluring offers of money so that he could stay in his laboratory and learn more about electricity.

A business bargain is the crisis in the life of James Watt. The pageant showed Watt in complete despair, his funds for experimenting exhausted, forming his famous partnership with Boulton, out of which came the first commercially successful steam engine.

The visit of the New York aldermen to Edison's laboratory to see if the new electric lights would be suitable for street illumination was chosen by Dr. Baker from the dramatic career of the aged inventor. The pageant also showed Alexander Graham Bell speaking the first words ever sent by telephone when he excitedly called his assistant from a distant room, "Mr. Watson, come here! I want you."

Incidents from the lives of Morse, the inventor of the telegraph, and Fulton, of steamboat fame, were also dramatized.

Installing 20 in. Mains by Jacking Method

How Two Protected Lines Were Placed Under Double Track Railroad Without Traffic Interference

NOT a moment's delay to traffic and a greatly increased saving in time and money were features of the recent installation at Marion, Ind., of two water mains under a busy double track railroad by the jacking method.

The city of Marion has recently completed a number of betterments to its municipal water-works which will improve the quality of the water and increase the capacity of its plant. The demand for a greater supply of water made necessary the construction of a large storage tank, 150 ft. in diameter. The only available space for a tank of this size was on the opposite side of a railroad which skirts the plant grounds on the south. Placing the new tank in this location created the problem of installing the two 20-in. water mains which were necessary to connect the new tank with the original 80-ft. tank on the north side of the tracks. The plans called for the one main to be placed at a depth of 21 ft. below track level and the other to be placed directly over this on a 7.8 per cent grade, with the upper end 10 ft. below track level.

The railroad under which these water mains were to be placed is a double track line connecting Chicago, Ill., with Columbus, O., and consequently is a very busy road. Therefore, the railroad officials were particularly desirous that the method of installation would not necessitate the issuing of slow orders or cause any other interference with its train schedules.

The construction company awarded the contract for doing the work proposed at first to effect the installation by means of tunneling and suggested this method to the railroad authorities. However, one of the engineers consulted had had experience with the Armco jacking method of placing culverts under traffic and suggested its use instead of tunneling as being more advantageous for both the railroad and the contractor. In this manner, the railroad would be spared any traffic interference and extra maintenance work due to a settling roadbed. Advantages of this method which appealed to the contractor were quicker construction and greater economy than the proposed tunneling method. For these reasons the jacking method was chosen to create the opening in which to place the mains.

An agreement was made with a nearby company fabricating pure iron corrugated pipe, to install the conduits by this method and according to directions given by the contractor. This called for two lines of 42-in. corrugated iron pipe placed at the required line and grade and of a length meeting the safety requirements of the railroad.

Working Trench Showing the General Arrangement of Jacking Setup, also Cover Over Excavated Material

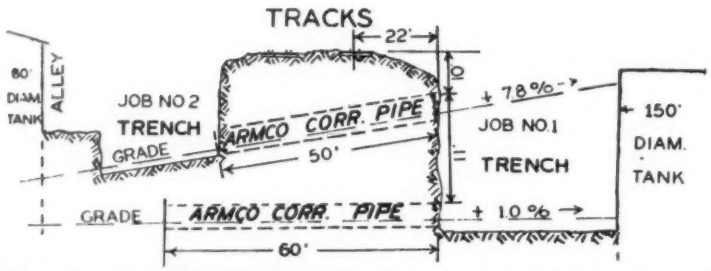
Installation.—A working trench for installing the lower conduit was prepared on the south side of the railroad. The excavated material was heaped up on both sides of the trench, and thus placed, it constituted a menace should rainy weather set in. Rather than remove this material which was later to be used for backfilling, it was considered to be more economical to provide a cover. This was done with salvaged lumber and sheeting covered with roofing paper. As a further protection a roof of the same material was placed on upright posts immediately over the working trench. The wisdom of these precautions was demonstrated during a heavy rain which fell while the job was in progress.

In the working trench thus prepared, the regular jacking setup was made and jacking started. The material encountered was a hard blue clay, slightly plastic in spots, which was excavated by means of air spades and a trench pick. As this material was excavated, it was removed on a small wagon which was drawn to the surface on skids placed at the rear end of the trench. A small hand operated winch was used to furnish the necessary power for this operation. As the excavation progressed, the pipe was advanced by pressure from the jacks.

When one of the 12-ft. sections of pipe had been jacked into the fill for a sufficient distance, the next section was lowered to the lining timbers by means of the skids which also served as a track for the wagon. This was connected to the section already jacked by a field riveted joint and jacking resumed. This process was repeated until the required 60 ft. of pipe was in place.

An approach trench for installing the upper conduit which was to be placed directly over the first was prepared on the north side of the track. The same setup used on the first job was made and operations were begun. The material first encountered was a hard yellow clay which was changed to newer and less stable filled ground as the job neared completion. This excavated material was removed from the pipe to the rear end of the working trench by the box and wagon. From here the box

All Traffic Over the Site Without Slackening Speed



Cross Section Showing Jacking Installation of 110 ft. 42 in. Corrugated Iron Pipe Conduits, Which Provided the Required Openings

was raised to the surface by a small hand operated derrick.

To rush both jobs to completion two shifts of 5 men, each working 12 hours, were used. With the required openings under the tracks made, the laying of the two water mains was easily accomplished.

Conclusion.—This job as completed reveals other advantages than those of non-interference to traffic, no roadbed maintenance and quicker and more economical construction. Laying the mains in a conduit possessing the strength of corrugated iron pipe, protects the main from the vibration of heavy traffic which passes over it. Even if a break should occur in spite of this precaution, the roadbed proper will be protected from washing and its attendant damage and danger to traffic.

The Burnipe Construction Co. of Columbus, O., had the contract from the city of Marion for the improvement of the water-works. They were represented on the job by their engineers, Earl Hoye, who expressed his complete satisfaction with the results obtained from the jacking method. The W. Q. O'Neall Co., of Crawfordsville, Ind., fabricators of Armco corrugated iron pipe, had complete charge of the jacking operations.

Efficiency of Water Purification Plants on the Great Lakes

THE United States Public Health Service has recently issued a report on the efficiency of municipal water-purification systems located along the Great Lakes, from which approximately 10,000,000 people derive their water supply and into which the sewage and industrial waste of about 5,500,000 population are discharged.* The report is based on a survey of 14 representative municipal water filtration plants situated on the Great Lakes and connecting waterways, including the plants of Detroit and Cleveland. The survey, which was made at the joint request of interested local and state authorities, was an extension of previous surveys of a similar nature made along the Ohio and other rivers of the Middle Western and Eastern states.

Owing to the great importance of the Great Lakes region from standpoints of population, commerce, and industry, the maintenance of safe water supplies along these lakes constitutes one of the major water-purification problems of the country. With the increasing pollution of sources of water supply located in various marginal zones of the lakes, this problem is becoming a more difficult one each year, taxing at present, in some instances, the resources of modern water purification.

The difficulties of obtaining safe purified water supplies from the Great Lakes are magnified considerably by the extreme variability existing in conditions of pollution of the lake waters at the several water intakes, which are located in or close to marginal zones of shore pollution, where water movements are subject to the vagaries of winds and countercurrents. In some instances the pollution of these zones probably is subject to seasonal variation, due to large increases in the sewered population residing along the lakes during the summer vacation season.

A study of the performance of the 14 Great Lakes plants included in the survey revealed some interesting similarities and contrasts in the behavior of these plants, both among themselves and in comparison with purification systems of the Ohio type. Perhaps the most striking similarity observed was the existence, at practically every plant, of a well-defined relationship between the bacterial quality of the raw water, as delivered for treatment, and the corresponding quality of the effluent produced at each successive stage of purification. This same relationship, which is one of fundamental importance, had been noted previously in studies of water purification on the Ohio River and on other rivers.

The most important dissimilarity observed was the marked variability in average bacterial efficiency shown by the several Great Lakes plants among themselves and their disparity in this respect from Ohio River plants of the same general type. Among the Great Lakes plants, divergences in efficiency were indicated as being due in some cases to differences in the average density of raw water pollution and in certain features of plant design and operation. In other instances no reason could be assigned for the inequalities noted.

As regards the comparative bacterial efficiency of the Great Lakes and the Ohio River plants, the former were shown consistently to be slightly less efficient with chlorination included, and decidedly less efficient with chlorination excluded, than the latter group. Detailed analyses of the data failed to disclose the reason for these divergences, which do not appear to be explained, as currently assumed, by the relatively lower turbidity of Great Lakes water. It is suggested that they possibly may be due to differences in the chemical composition of the two waters, notably in the hydrogen-ion concentration.

From a study of the relationships observed between the bacterial qualities of the raw waters and effluents of the Great Lakes plants, and from an analysis of their variations, it was concluded, in so far as the production of final effluents conforming to the revised Treasury Department B. coli standard is concerned, that an average density of B. coli in Great Lakes raw waters, as delivered for purification, approximating an index of 4,500 per 100 cubic centimeters appears to represent an upper limit of permissible pollution, beyond which a majority of the Great Lakes filtration plants, as at present designed and operated, would be clearly overburdened. Mean densities ranging from 1,000 to 4,500 per 100 cubic centimeters represent a doubtful zone, within which some plants might be and others might not be overburdened for a significantly large proportion of the time. With average densities ranging below 1,000 per 100 cubic centimeters, the majority of such plants would not be expected to be overburdened except for a comparatively small proportion of the time.

Among the areas studied, the most highly polluted zone of the Great Lakes from which water is taken for purification was located at the extreme southern end of Lake Michigan, where existing purification systems are clearly overburdened. Other zones of relatively high, though not in all cases excessive, pollution was found to be at the extreme western end of Lake Erie, at the outlet of the Detroit River, and along the southern shore of Lake Erie between Cleveland and Sandusky.

*Studies of the Efficiency of Water Purification Processes. IV. Report on a Collective Survey of the Efficiency of a Selected Group of Municipal Water Purification Plants Located Along the Great Lakes. By H. W. Streeter. Public Health Bulletin No. 193.

Recent Progress in the Art of Water Treatment

A Review of the Outstanding Developments That Have Occurred During the Past 25 Years

By ABEL WOLMAN, WELLINGTON DONALDSON and L. H. ENSLOW

Respectively, Chief Engineer, Maryland Department of Health, and Editor-in-Chief, Journal of American Water Works Association; With Fuller & McClintock, Consulting Engineers, New York, N. Y.; Research Chemist, The Chlorine Institute, New York, N. Y.

ON this occasion, marking as it does an important milestone in the history of the American Water Works Association, it is appropriate to take stock of the developments in the art of water treatment during the past 25 or 30 years. In such stocktaking our aim has been to avoid undue complexity and detail in describing new processes and new principles and to present in as simple terms as possible the practical significance of such advances in the art as have occurred in the past quarter of a century. In accomplishing this task, some omissions no doubt have been made in the review, some failures have occurred to recognize priorities, some undue variation of emphasis on importance of contribution is likely to appear, but their excuse lies only in the desire to simplify scattered information for the most practical use possible. Extensive bibliographies have been intentionally omitted and undue references to responsible authorities have likewise been curtailed in order to save space.

Preliminary Sedimentation.—Water has been settled to remove living and non-living materials for many centuries. Improvements in this art are primarily resident in changes in containers and in the development of mechanical devices for the removal of accumulated materials. The best recent examples are perhaps at the plants at Kansas City, Mo., and the new Howard Bend Works at St. Louis. Adequate settling of solids and rapid removal of their accumulations are important assets on especially turbid waters of the Missouri River type.

Interesting contrasts to these procedures are in use at Louisville, where sediment from preliminary sedimentation basins and from coagulation basins, is returned to the raw water when it is unusually clear. At Winnetka, Ill., ground brick clay is added by a dry feed machine to produce artificial turbidity.

Coagulation.—Aside from the rejuvenation of old coagulants and the development of new ones, the most important advance in this phase of the art of treatment is probably in the better understanding of the mechanism of coagulation, with the resulting economies and higher efficiencies attainable thereby. This conclusion appears to be valid when it is recalled that as early as 1903 William B. Bull used ferrous sulphate and lime coagulants at Quincy, Ill.; that, in 1911, he patented the application of ferric chloride, made from chlorine gas on scrap iron, to coagulation; that almost two decades ago excess alum coagulation and split coagulation were used at Springfield, Mass., and that Hale advanced new hypotheses in 1913 to account for observed results on the coagulation of colored waters with alum.

Many of these empirical observations have been later confirmed when more adequate principles and tools were available for testing them.

Perhaps the earliest emphasis on the underlying mechanism of coagulation, with particular reference to the importance of hydrogen-ion concentration rather than alkalinity and to the significance of an iso-electric point for coagulation, was by Wolman and Hannan not quite ten years ago. These observations were important primarily in stimulating discussion and experimentation in the effort to clarify understanding of the coagulation process. That these efforts on the part of a great many workers were successful is attested by the fact that this particular process in treatment is now more scientifically and economically controlled than a decade ago. Much has been contributed to this understanding by the work of Buswell and Edwards in 1922, by Theriault and Clark in 1922 and by Miller in 1924. To these investigations a number of the later developments in coagulation may be traced.

It is impossible to give a complete list of the modifications in and additions to coagulants which have appeared in less than ten years, beginning perhaps with the suggested application of sodium aluminate by Spencer and its gradually extended usage in the municipal and industrial field, either alone or in conjunction with filter alum. Although not universally applicable, it has found a field of importance where its use has been efficient and economical. At about the same time, Coe described a coagulant prepared from 1 part of soda and 4 parts of alum for use in softening processes. DeLaporte was perhaps the first to make practical use of this mixture. The aluminate is now available as a solid material for dry feed equipment. Powell and Christman in 1925 did much to determine the field of application of sodium aluminate with or without alum, and Hedgepeth not so long after showed its effectiveness in conjunction with ferric iron coagulants.

Following the studies by Mohlman and Palmer in 1926 with chlorinated copperas by oxidation of ferrous sulphate solution with chlorine, in sewage sludge dewatering, Enslow and Hedgepeth in 1927 made their first application to the highly colored water at Elizabeth City, N. C., with unusually successful results. Beneficial results of high order have since been obtained at Chickasaw, Ala., Hertford, N. C., Mamaroneck, N. Y., Warren, R. I., and the Chicago experimental filtration plant. In this connection, it is important to point out, largely because it is in contradiction of text book notations of past years, that the best coagulation of these highly colored waters with ferric compounds is at very low rather than at very high pH values.

This is likewise a desirable time to recall to this group that at the 1906 meeting of the American Water Works Association at Boston, the late Prof. George C. Whipple called attention to the "ferro-chlor" process developed by Dr. Duyk and used successfully as a coagulant at the Middlekerke, Belgium, plant, as early as 1902. Whether it was the excessive cost of this coagulant or for some other reason, the process has been quite completely ignored during the intervening 25 years. It now receives a new lease on life and probably will find its place in the armamentarium of the water plant operator. More recently Wilson at Los Angeles, Calif., has found ferric chloride the most effective coagulant for a colored well water supply at Wilmington, Calif. The work of Hopkins (1929), as to the value of trivalent iron in coagulation practice, should be given mention in this connection.

In summary, therefore, the new processes in coagulation rest upon a foundation of better understanding of the mechanism of coagulation. Some of the new coagulants come into use because their methods of production and consequent cost are lower than a decade ago. Their value is in supplying the water plant operator with a more varied choice of coagulating materials. The trend of their use is in the direction of complexity. All of which simpy means that the better the understanding of this phase of water treatment, the more likely we are to develop processes of coagulation which will be specific for certain waters and which will be regulated with a higher degree of information and scientific understanding than has been the case in previous years.

Chlorination.—Some of you may recall some five or six years ago the

debate among sanitarians and water works operators as to where chlorine should be used and why. That debate has now shifted to the question as to where chlorine should not be used and why not. One of the remarkable developments in the field of water purification in the last ten years has been in the widening application of chlorine and its compounds for innumerable purposes. Revivals of application, increase in understanding of mechanism and empirical applications without understanding, but frequently with good results, are the characteristics of the history of the use of this compound in water treatment. Over 30 years ago Sims Woodhead in England employed chlorine as a temporary expedient during a typhoid fever epidemic at Maidstone, England. Its use in ferro-chlor by Dr. Duyk has already been referred to. Perhaps the first large scale application of this compound to water disinfection was by Sir Alexander Houston in 1904 on the Lincoln plant of London. One of the most important contributions to sanitary science was thus made by Sir Alexander in providing for the City of London, through the expedient of chlorination, a water of hygienic safety for a quarter of a century.

The operations in 1908 at the Chicago stock yards and shortly thereafter at the Boonton, N. J., headworks of the Jersey City water supply, both by George A. Johnson, mark the first large scale introduction of this process in the United States. Of no less importance was the early qualitative use for the detection of free chlorine by orthotolidin by Earl B. Phelps, its subsequent study by Professor Sedgwick and F. W. Jones and its further quantitative extension by Ellms and Houser in 1913. The vast importance of the ortho-tolidin test in the practical control of chlorination, however, was not fully emphasized until the chlorine control phases resident in the development of the residual chlorine determinations in Maryland were clarified by Wolman and Enslow during the period 1917 to 1919.

Real progress in the use of these compounds, however, dates from the initiation in 1910 of the use of liquid chlorine by Major Darnall of the United States Army Medical Corps at Fort Meyer, Va. Two years later, liquid chlorine was applied at the Niagara Falls, N. Y., municipal plant through an Ornstein solution feed equipment, developed in cooperatoin with Mr. Harry Huy. From that time to this its application has been extended throughout the world, its control has been improved, its possibilities have been multiplied, its results have been recognized, and the understanding of its action only little improved.

Practically all of the extended applications of chlorine within the last ten years have resulted from the pressure placed by the public upon the water-works operator to produce a drinking water which would be not only hygienically safe, but fit to drink from the comfort standpoint. Tastes and odors have been the blessing of the water-works field, although many an operator would suggest the reverse at the moment when the consumer is pestering him to the utmost on account of the objectionable tastes and odors in the supply. Although the blessing may have been one in disguise, the results of these demands by the public have been and are advantageous.

Originally the trouble from tastes and odors was blamed upon faulty chlorine dosage control. No doubt much of these difficulties, in the days of constant dosage of chlorine, may have been due to true excess or free chlorine. When a great many of these tastes and odors persisted, however, after careful control was introduced and residual chlorine tests were the standing practice in virtually all the plants in this country, it became necessary to search further for a remedy. The work of Race in 1917 at Ottawa, Canada, with chloramine, produced ammonia water and bleaching powder, marks one of the first efforts to obtain a substitute for liquid chlorine or hypochlorite. Although the process did not find wide appliaction, it still survives at Ottawa as a more ecomonical and efficient procedure than the earlier bleaching powder process. In the same way pre-chlorination, i. e., chlorination of raw water before application to the filter beds, was practiced for purposes of disinfection at Harrisburg, Pa. in 1912, and by Powell at Avalon, Md., in 1916. In this field again, application of this plan was delayed considerably by the general tendency of water-works people to delay the use of new procedures until they have demonstrated their value completely.

Pre-chlorination, however, has resulted in the saving of many thousands of dollars in alum required for adequate coagulation. The experience of Howard at Toronto, Ont., since 1921 and by workers elsewhere testify to this conclusion. The chief results of the procedure appear to be in more adequate algae control in basins and filters, lower bacteriological loadings on the filters, improvement in filter bed condition, reduction in wash water consumption, improvement in coagulation and general over-all factor of safety in plant operation. Practical observations by Weston, Howard, Caird, Mangun, Watkins, Whitener, Cohen and Scheepfle, confirm these general conclusions.

Special mention should be made of the increasing application of chlorine to the control of algae growths, largely the result of studies by Hale in 1921. Practical use of chlorine for this purpose has since been made at Lufkin, Tex., by Chester Cohen, at Kansas City, Kan., by Mangun and more elaborate observations by Hale in 1929 on the New York City water supply. Similar extensions of the use of chlorine have occurred in the industry, particularly in treating condenser water to eliminate so-called "slime" deposits, resulting in longer usage of condenser tubes and greater efficiency of heat transfer. Ice plants find the chemical useful to prevent the algae coating of cooling coils. Although this application is of recent date in this country, chlorination of condenser water has been used for a number of years in England. Similar slime growths in paper mills are now being controlled by the chlorination of water supply in re-circulated "white water."

Pre-Ammoniation. — Sir Alexander Houston, recognizing the superior advantages in some instances of chloramine, first suggested the application of ammonia prior to chlorine, in order to avoid tastes resulting from secondary reactions from chlorine with organic material. Apparently saturation of the organic compounds in water with ammonia, at least in some waters, prevents the creation of tastes and odors upon subsequent application of chlorine. In America this was first demonstrated by McAmis at Greeneville, Tenn., and shortly thereafter by Spaulding at Springfield, Ill. The elaborate investigations by Braideck in 1929 at Cleveland, O., showed the value of the process as one of the most practical and economical measures for taste prevention. A number of months of plant operations since the initial experiments at Cleveland seemed to prove that pre-ammoniation is one of the very helpful deterrents to taste and odor production by chlorination. It is important to point out that the cost of pre-ammoniation is reduced by some saving of chlorine. Whether or not it may be universally employed can only be tested empirically. The ammonia dosage required is generally 0.25 p.p.m. of ammonia or less. In addition to the places already mentioned the process is in use at Lancaster and Erie, Pa.; at Cleveland, Warren, Defiance and East Liverpool, O.; Mamaroneck, N. Y.; at the Hyattsville plant of the Washington Suburban Sanitary District and at Burlington, N. J.

Permanganization.—Again the water-works profession is indebted to Sir Alexander Houston for the development of another process of taste prevention or destruction with permanganate, through his work in 1925 and 1926. As far as we can discover James N. Caird was the first worker in America to use potassium permanganate with success in taste elimination or prevention. In 1929, Harrison at Bay City, Mich., applied permangante to the raw water in sufficient quantities to carry the pink color of the permangante through the mixing chambers. In 1930, Rosenthal made use of the same process in the Dallas, Tex., raw water, also with success. In this instance, too, wider application of this chemical has been delayed either because of the fear of

manganese troubles or the cost of permanganate. Those who have used the process have had considerable success and some prefer it to ammonia treatment. Observation appears to indicate that waters of high dissolved organic content contributed by industrial wastes or decayed vegetation are somewhat more amenable to permanganate treatment than to ammoniation. Waters, on the other hand, containing only small amounts of the end products of decayed vegetation or organic industrial wastes are amenable to preammoniation. In some instances permanganate has aided coagulation, apparently due to the "flocking out" of manganese with alum or iron.

At the present writing permanganate has been used at intervals at about ten plants in America, in quantities varying from 0.04 to 1.0 p.p.m. The plants include Bay City, Mich.; Dallas, Tex.; Rensselaer, N. Y.; Roanoke, Va.; Western New York Water Co. of Lackawanna, N. Y.; Rochester & Lake Ontario Water Co., at Rochester, N. Y.; Newberry, S. C.; Mamaroneck, N. Y.; and East Chicago, Ind.

Super and De-Chlorination.—Both Adams and Houston experimented successfully with super and de-chlorination in 1924 and 1925. Under the guidance of Norman J. Howard, super-chlorination and de-chlorination with sulphur dioxide gas were started in Toronto, Ont., in 1926. Since 1927, it has been used continuously and on a large scale to prevent tastes in the Toronto supply whenever the wind direction blows pollution from the harbor out to the intake in Lake Ontario. The process has attracted international interest and apparently has proven successful, not only at Toronto but elsewhere. Under the supervision of Hale it has recently been used at Jamaica, N. Y., with success.

Activated Carbon Filtration.—Great progress in the study of tastes and odor elimination by filtration through beds of activated carbon has been made in America within the last two years. Many years ago, however, charcoal beds were employed abroad and the use of activated carbon in conjunction with sand filters was introduced in England many years ago by the Candy Filter Co. of England. Perhaps the most extensive studies of activated carbons in this country have been those made by Baylis. Additional observations have been made by Behrman, Weston and Norcom and G. R. Spaulding.

Baylis first demonstrated on a small scale the remarkable properties possessed by certain activated carbons, particularly a commercial brand known as "hydrodarco," in removing chlorine and by-product tastes. Apparently it is desirable to superchlorinate the water and remove the chlorine excess by activated carbon rather than to depend upon the by-product taste compounds being removed continuously, with the risk of some of these tastes passing through the filter. The excess chlorine aids somewhat in keeping the carbon activated.

From present available data a "Hydrodarco" carbon filter bed, 24 in. deep, will remove between 1 and 1.5 p.p.m. residual chlorine continuously for 11 months or more, before re-activation becomes necessary; that is, before enough free chlorine passes through the bed to be objectionable. These findings give a surprisingly long period of service for a carbon bed which was operated at a rate of 2 gal. per square foot per minute.

To date there is no record of a municipal carbon filter installation in America. There are one or two in Germany of recent installation. They have been entirely successful and the filters have required regeneration about every three months by steaming out. Important experimental observations have been published in Germany by Imhoff and Sierp.

There are, however, in the United States, a number of bottling plants which have used successfully activated carbon filters. Food products establishments are installing them and one hospital is on record as intending to superchlorinate and de-chlorinate its water supply by this method to produce a sterile water supply for the building.

The process should possess a particular appeal to the smaller municipalities, which may not have careful supervision of chlorine treatment of the public supply. In such instances overdosage could be the usual method, with removal by-carbon filtration of excess chlorine and resulting taste compounds after relatively short contact with the chlorine. Improved palatability of the water should result.

Correction of Corrosion Difficulties.—In this field, as in others, great progress has been made in the last ten years in making use of knowledge which in some instances was available a number of years prior. Again application of known principles and the development of new techniques wait upon public demand. When this demand becomes insistent enough old procedures are rediscovered and new ones are added. Some 20 years ago D. D. Jackson used soda-ash to correct corrosion troubles at Long Beach, L. I., N. Y. Tillmans, many years ago, studied the mechanism of corrosion and pointed out the importance of dissolved oxygen, carbon dioxide, and hydrogen-ion concentration. In 1912, Hale made extensive studies on the importance of dissolved oxygen in corrosion and of the secondary importance of carbon dioxide. He reported upon his findings in the "American Journal of Public Health" in 1913, Vol. 3, page 1337.

The first use of sodium silicate in a municipal supply in this country was in 1923 by Weston, to correct difficulties with lead solution. Speller's work in 1923 deserves special mention as clarifying the mechanism of pipe corrosion and suggesting means for correction. His comments on the importance of dissolved oxygen and pH and of the effect of temperature and velocity of flow through the pipes have done much to make more intelligent the control of this problem. Scientific application of chemicals to prevent corrosion were made in the use of lime by Hechmer at Hyattsville, Md., by Baylis at Baltimore and by Watkins at Norfolk, Va. About the same time the use of caustic soda for this purpose was introduced at Charleston, S. C., and at the West Virginia Pulp & Paper Co. plant at Luke, Md.

More extensive studies were carried out in New York by Hale in 1928, in order to determine the effect of various chemicals in the prevention of corrosion on steel, brass, lead and wrought iron pipes. In his studies, soda ash, silicate and lime, under hot and cold water conditions, were employed.

In general, it may be stated that corrosion difficulties in most instances may now be corrected with economy. Sufficient information is available to present an understanding of the chemical balance of the water supply necessary to avoid corrosion. A convenient index of the probability of corrosion is afforded by the dissolved oxygen reduction in portions of the distribution system. Elimination of carbon dioxide by aeration or by the application of chemicals or by both is a practicable procedure. The establishment of a chemical balance adequate to protect distribution pipes is feasible. No longer is it necessary to distribute a water through a distribution system with resulting destruction of the pipe carrying the water.

As C. P. Hoover recently points out: "Simple tests for determining equilibrium or chemical balance have been devised. It is possible to determine easily whether water delivered to consumers is saturated, supersaturated or undersaturated with calcium carbonate. This is done by adding calcium carbonate to the water in excess. If the water is undersaturated, the alkalinity will increase; if saturated, it will remain constant; if supersaturated, it will decrease. Water that is supersaturated with calcium carbonate will deposit a coating on the inside of pipes, and if continued too long the pipes will become clogged. On the other hand undersaturated water may cause corrosion."

Water Softening.—The American public has been slow in taking advantake of knowledge existing for almost a century as to how to reduce the soap consuming constituents of the water supply. A process for softening water was invented by Clark, a Scotch chemist, in 1841. Progress in the introduction of the process, however, has been very slow, apparently due to lack of understanding on the part of the public, both as to the needs for softening and as to the available economical procedures. One of the first municipal

plants installed in this country was in 1901 at Winnipeg, Man., where almost 30 years ago, it is interesting to note, re-carbonization using carbon dioxide from burning coke was developed and applied by J. O. Handy, then chief chemist of the Pittsburgh Testing Laboratories.

The first municipal softening plant apparently was at Oberlin, O., and was placed in operation in 1903. Although the excess lime treatment has been previously used in industrial and railroad water softening practice, the first application to municipal softening practice was made by C. P. Hoover at Columbus, O., in 1908. The process resulted in softening water and in higher bacterial reduction, with the use of recarbonation. The value of the excess lime treatment was first pointed out by Sir Alexander Houston. In 1918, Youngstown, O., began the use of excess lime, in this instance, however, for the definite purpose of increasing the bacterial destruction and in order to avoid the use of chlorine on a water containing a number of industrial wastes of taste producing character.

The first large scale use of re-carbonation, that is, the application of carbon dioxide to a water chemically softened in order to avoid the deposition of lime products in filter beds, distribution lines and service pipes, was at Owensboro, Ky., in 1912. Interest in this process lagged, however, until about 1921 when C. P. Hoover gave additional emphasis to its value. The first large scale application of the process was at Defiance, O., at about this same time.

A similar revival of interest has occurred in the use of the zeolite process which was recognized and patented in England in 1896. Apparently zeolite material was first artificially produced in America by Gans in the form of "permutit" in 1913.

Zeolite is sodium aluminum silicate, but becomes calcium magnesium aluminum silicate after hard water is passed through it. It may then be regenerated or reverted to sodium aluminum silicate by backwashing it with a solution of common salt (NaCl). The hardness of water when passed through active zeolite softeners at proper rates is reduced to practically zero.

Although it was used primarily in industrial plants, within the last two or three years considerable interest has been created in its application to large municipal plants. Installations within the past two years have been made at the municipal plants at Sewickley, Pa., and at the Ohio Valley Water Co. plant near Pittsburgh, Pa. The advantages of the process appear to be in the simplicity of control due to the fact that only one chemical is needed, common salt; changes in hardness of raw water are not subject to manipulation and control on the part of the operator and there is no sludge. On the other hand, the water passing through a zeolite softener must be clear and softened water contains residual sodium bicarbonate which in some instances may create difficulty.

An interesting variation of the use of the zeolite principle is at the Bremen, O., plant, where both ferric and ferrous iron are removed from the water, in addition to producing a reduction in hardness.

C. P. Hoover has within the past year made another important contribution to the practice of water softening in pointing out the advantage of using excess lime, carbonation and return sludge in the water softening process. By this plan he has succeeded in reducing the carbonate hardness of all types of water and under all temperature conditions to almost the theoretical limit of solubility, that is, to less than 20 p.p.m. This accomplishment is of great practical importance, in as much as until recently an average reduction of carbonate hardness to 50 or 60 p.p.m. was considered excellent, with many softened waters frequently producing 85 to 95 p.p.m. of hardness after softening.

Perhaps the outstanding feature of inportance in the water softening field is the neglect of the general public in insisting upon its wider use. Buswell has recently pointed out that in Illinois every public supply should be treated for the removal of hardness and yet in that state only 1 per cent of the municipalities have water softening plants. Probably not over 10 per cent of the water supplies in this country which should be softened are subjected to that treatment. The economic waste due to this fact is great. Simple and economical processes are available. Why are they not used?

Iron and Manganese Removal.—The recognition of the importance of removing minute quantities of manganese in waters is relatively of recent origin. The removal of iron, however, has been given a great deal of attention in the past, although the number of installations is still small. Practically all the earlier installations depended upon aeration and filtration through contact beds of gravel, charcoal or cinders for the deposition and removal of iron and manganese. Weston was one of the pioneers in the development of these processes. Pirnie in 1923 pointed out that excessive aeration was undesirable and that contact beds of gravel with upward flow give satisfactory iron removal results. Installations of this character are in use since that time at Long Beach N. Y., Stuart, Fla., and Punta Gorda, Fla.

In 1924, Baylis added to the knowledge of manganese removal by his studies at Baltimore, where he found that increased pH, accompanied by the addition of lime and iron in coagulation, proved more effective in the removal of manganese than by the use of alum. Pre-chlorination apparently was also helpful. The experimental observations by Donaldson at Memphis, Tenn., in 1921, have established quantitative standards for the removal of dissolved gases by aeration and by contact cinder beds in trays.

Kuhr's observations on biological aspects of manganese removal in Holland in 1927, although still controversial, have added to the interest in this problem. His studies on the effect of manganic oxide in absorbing manganates from super-chlorinated water by contact with manganese dioxide are of great interest.

Practical control of manganese deposits and manganese mud balls in filters has been accomplished by Derby in 1928 at Beverly Hills, Calif., by super-chlorination of the beds and 12 hours standing at intervals.

Development in Analytical Methods and Laboratory Control.—A summary of the contributions in this field is by no means simple, largely due to the fact that many of the procedures are still under discussion, some are under attack and some have limited application. It is useful, however, to refer to the more important of these procedures for purposes of record. This is particularly desirable in view of the extensive operations during the past five years of Committee No. 1 of the American Water Works Association which deals with standard methods of analyses.

The studies in 1926 by Buswell and Boruff on ortho-tolidin and starch iodide methods for residual chlorine determination have been of great practical importance. Enslow and Tiedeman have made similar observations.

In the field of boiler water analysis the development by Bardwell in 1926 of a rapid method for determining various types of hardness in boiler water has facilitated industrial and railroad water softening control to a considerable extent.

Since 1928, important contributions in this field may be summarized as follows:

(a) The development of an important and accurate method for phenol determination by Gibbs and its modification by Baylis for appliaction in the sanitary field.

(b) The procedure for bi-chemical oxygen demand determination has been much more carefully studied and accordingly improved under the leadership of Mohlman in this country and Sierp in Germany.

(c) Considerable emphasis has been placed upon improving the methods of detection of the B. Coli group of organisms. The development by Salle and Noble of direct plate methods for growing and counting B. Coli, although still in an experimental stage, is of great imprtance in pointing the way to future simplification of bacteriological water examination. Extensive work on selective dyes by Jordan, Hale, McCrady, Levine, Dunham and other workers

should lead in the near future to practical and valuable changes in standard tests for the B. Coli group.

(d) An improved method for estimating manganese has been proposed by Forman, in which manganese is oxidized in alkaline solution and orthotolodin is employed to produce a yellow color which may be compared with standards.

(e) Improved methods of measurement of suspended matter in water are being studied by Baylis.

Of general importance in this field has been the development in 1917 of the eosin-methylene-blue plate method for identification of B. Coli by Max Levine; the preparation and commercial development in 1921 of convenient pH standards; the preparation of standardized and economical dehydrated culture media in 1923; the development in 1924 by Hale of an electrolytic, colorimetric and volumetric determination of copper in water; improved methods of determination of iodine in water by McGlendon, Clark, Daniels and others in 1926; quantitative studies of phenols in water by Donaldson and Furman; the use of chlorine demand of a water as an indicator of organic content by Froboese in 1920, Keiser in 1926 and Meadow and Hale in 1927; the development of the orthotolidin methods for dissolved oxygen determination by McCrumb and others in 1929; and the development of a technique for measuring hydrogen sulphide by Salle and Reinke in 1929 by the use of antimony sulphide with colorimetric comparison with standards.

Acknowledgment.—The foregoing is an abstract of a paper presented June 3 at the 50th annual convention of the American Water Works Association.

Automatic Water-Level Indication by Telephone

The water elevations of the filtered-water reservoirs of the Washington, D. C., water supply are plumbed in a novel manner, described by Dewey M. Radcliffe, associate engineer, U. S. Corps of Engineers, Washington, D. C., in a paper presented before the St. Louis convention of the American Water Works Association. Each reservoir is provided with an automatic level indicator, which, by means of a standard Bell telephone subscriber's station, will transmit the water level to any telephone connected to the system. The following description is abstracted from Mr. Radcliffe's account.

In a small building on the site of each of three reservoirs in widely separated sections of the city, a complete water-level indicator and transmitter, with all of its equipment, is installed.

It consists chiefly of three parts: a relay operated by telephone-ringing current, furnished by the telephone company; a cabinet, housing miscellaneous relays and selector switches, attached to the front of which is an ordinary desk-type telephone instrument with a swinging arm supporting a small loud speaker directly in front of the telephone transmitter, and a float-operated selector switch connected by a multi-conductor cable with the housing cabinet. Other types of indicators were studied but eliminated, due to the long distances between reservoirs and filter plant and pumping stations, and to the high cost of line construction or line-leasing cost. This led the engineers to select a device which would operate over the standard telephone at the regular subscriber's monthly rate and insure 24 hours' reliable service per day. This type of indicator allows any official of the water supply system to check the condition of the reservoirs from any point.

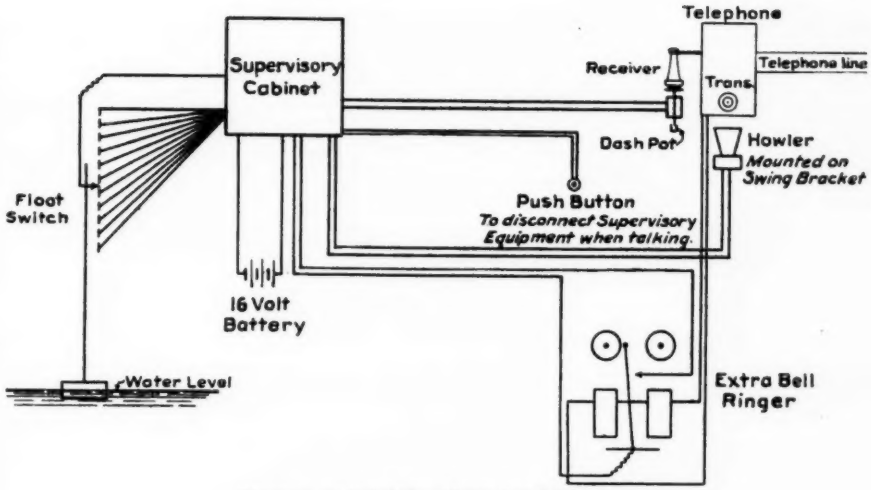


Diagram of Telephone Water-Level Indicator

The indicator does not interfere in any way with the electrical operation of the telephone circuit, as only sound is transmitted and no electrical connections are made to the telephone circuit.

The automatic operation is started by giving a stated telephone number to the operator, who rings the number called, causing the relay in the transmitter house or reservoir site to operate, thus energizing the various relays and switches of the transmitter. These cause an electromagnetic device, in the form of an arm coming through a small aperture in the housing cabinet, to lift the receiver and hook of the telephone and hold the receiver in off-hook position until the signal has been transmitted, after which the magnet is de-energized and the receiver is returned to normal on-hook position. The indicator operates equally well on the dial telephone system. In this case the telephone number of the indicator is dialed in the usual way.

When the receiver is lifted, a selector switch in the housing cabinet causes a series of buzzes to be originated; these are amplified by an audio-transformer, and passed through the small loud speaker, called the "squawker," mounted in front of the transmitter. The number of buzzes corresponds to the position of the float-operated selector switch—in this case the depth of the water, in feet, contained in the reservoir. The signal is repeated so that the person receiving the indication can confirm the original report, after which the receiver is restored to normal, as mentioned above, and the complete mechanism is in position to record the next call.

The telephone instrument used in conjunction with the water-level indicator may be used without any alterations or changes for ordinary talking purposes by merely lifting the receiver from the hook and swinging the small loud speaker out of position. At the conclusion of the conversation, the loud speaker will automatically swing back to position in front of the transmitter.

A delayed action of the starting relays is employed so that the equipment will only transmit upon a sustained ringing indication, as normally transmitted by the automatic telephone ringer. This eliminates all possibility of the mechanism being affected by lightning or other interference on the telephone wires.

These instruments have been used by the U. S. Corps of Engineers in Washington, D. C., for two years, in connection with the development of their new filtration plant at Dalecarlia, D. C., under supervision of Maj. Brehon Somervell, U. S. district engineer, assisted by Edward D. Hardy, principal engineer, and P. O. Macqueen, civil engineer. They have given 24 hours of unfailing service every day during this period.

The telephone water-level indicator was designed and developed by Mr. Radcliffe. The equipment was manufactured by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Sewage Sludge Used by City Parks

Dried sludge from the sewage treatment plant at Lakewood, O., is stockpiled and used in the city parks. The sludge is used in plantings and is mixed with soil for use on the fairways of the public golf course.

Water Company Rules and Regulations

An Excellent Procedure for Governing the Relations Between the Utility and the Consumer

NOTHING is more important to a water company than that its rules and regulations for the guidance of its customers should be reasonable, comprehensive and readily understandible. A very excellent set of rules, which should be of considerable interest to any water company, is given in a recent decision of the Pennsylvania Public Service Commission in the case of the Snow Shoe Water Co. The company was ordered to file, post and publish the rules, which were as follows:

Application for Service.—1. Service connection will be made, and water will be furnished, upon written application by the prospective consumer (or his properly authorized agent), on a blank prepared by the company for this purpose, and after the approval of such application by the company. The application for service shall in general clearly outline the class, scope and type of use to be made of the service, as well as the purpose for which it will be used.

2. The application and these rules and regulations constitute the contract between the consumer and the company; and each consumer, by the taking of water, agrees to be bound thereby.

3. A new application must be made to, and approved by, the company upon any change in the identity of the contracting consumer at a property, or in the service as described in the application, and the company may, upon five days' notice, discontinue the water supply until such new application has been made and approved.

4. Each application for service shall be made in conformity with and stating the basis of rates applicable to consumers under the tariff provisions.

Service Connection.—5. The company will make all connections to its mains, furnish, install and maintain all service lines from the main to and including the curb cock and box, which shall be placed from one to two feet inside the curb line, all of which service line shall be the property of the company and shall be accessible to and under its control; with the exception of public fire hydrants which may be installed and maintained at the expense of either party, as may be agreed upon.

6. All service lines from the curb to the house shall be of pipe approved by the company, laid at least 4 ft. below the surface of the ground and kept in good repair at the expense of the consumer.

7. No service pipes shall be laid in the same trench with the gas pipe, sewer pipe or any other facility of a public service company, nor within 3 ft. of any open excavation or vault.

8. There shall be placed in the service pipe, within the wall of the building supplied, and so located as to drain all of the pipes in the building as well as the meter, a brass, lever handle stop and waste cock, easily accessible to the occupants, for their protection in enabling them to turn off the water in case of leaks and to drain the pipes to prevent freezing.

9. Hereafter in all future installations or re-installations of service lines, only one property will be supplied through one service pipe. Where more than one property is now supplied through one service pipe, and under the control of one curb cock, any violation of the rules of the company by either or any of the consumers so supplied shall be deemed a violation as to all, and the company may take such action as could be taken against a single consumer, except that such action shall not be taken until the innocent consumer, who is not in violation of the company's rules, has been given a reasonable opportunity to attach his pipe to a separately controlled service connection according to Rules 5 and 6. Whenever a service pipe supplying two or more consumers may for the purpose of stopping leaks or making other repairs, require the main stops to be closed it will be replaced by a separate service line with curb cock and box for each supply according to Rules 5 and 6. Where one service pipe has been used for two or more properties held in one ownership, and there be a division of such ownership, whether by sale or otherwise, each property will, thereafter, have its own service pipe according to Rules 5 and 6.

10. All leaks in service lines from the curb to, and in and upon, the premises supplied shall be promptly repaired. On failure to make such repairs with reasonable dispatch the company may turn off the water and it will not be again turned on until all proper and necessary expense incurred in shutting off and turning on the water, are paid in full.

11. The company shall in no event be responsible for maintenance of, or for damage done by water escaping from, the service pipe or any other pipe or fixture on the outlet side of the curb cock; and the consumer shall, at all times, comply with state and municipal regulations in reference thereto and shall make any changes thereon required on account of change of grade, relocation of mains or otherwise.

Use of Service Must Be in Accordance with Application and Contract.—12. The use of water service by a consumer shall in general be in accordance with the class, scope and type of use, and the purpose stated in his application and service contract. A consumer shall not use, or allow use by others of water service through his service facilities for others or other purposes than covered in his application. (See Rule 34.) A new application and contract will make service for other purposes, or character of use, available.

Availability of the Different Classes of Service and Rates.—13. The various classes of service and rates are available to a consumer in accordance with the obvious intent of, and statements as to application made under the different rates in the schedule of rates.

Flat Rate Consumers.—14. Charges will be made for all water outlets or other facilities for utilization of service on the consumer's premises, except such outlets or facilities as have been disconnected or dismantled to the satisfaction of the company, or as provided in Rules 15 and 32.

15. For installed hose connections, hot water, heating plant or steam heating plant, within the period the service contract is in force and within the year, charges will be made from April 1 to April 1; because rates for these types of service are based on a seasonal use, which is usually only a fraction of a year, and the charge is divided equally among the four quarterly bills of the year. Therefore charges shall begin or cease on these items the preceding April 1 or the following April 1 for any such facility installed or dismantled, respectively; provided the charges shall not cover any period outside of the consumers service contract period.

Metered Consumers.—16. Each metered rate consumer's service shall have a separate meter to register the amount of water consumed, except as provided in Rule 50.

17. Railroad tanks, public garages, hotels and school houses will be supplied at meter rates only.

18. All meters will be furnished by, and remain the property of, the company and shall be accessible to and subject to its control. They shall be conveniently located within the building supplied, at a point approved by the company, so as to control the entire supply; and a proper place and protection therefor shall be provided by the consumer.

19. In any case where it is not convenient to place the meter within the building, as provided in Rule 18, the company may place it outside the building in a concrete or brick vault provided with a suitable cover and lock and key. Said vault shall be built inside the property line at the expense of the consumer.

20. In all cases where steam or hot water under pressure is used, a swing check valve must be placed, at the expense of the consumer, directly ahead

ADVERTISING PAGES REMOVED

of the meter and before any outlets are taken off from the service pipe, to prevent injury to the meter.

21. Meters will be maintained by the company as far as ordinary wear and tear is concerned but the consumer shall be responsible to the company for any injury to, or loss of, any meter arising out of or caused by, the consumer's negligence or carelessness, or that of his servants, employees, members of his household, or any person upon his premises under or by his consent or sufferance. The consumer shall permit no one, not an agent of the company or otherwise lawfully authorized so to do, to remove, inspect or tamper with the company's meter, or other property of the company on his premises.

22. The quantity of water recorded by the meter shall be conclusive on both the consumer and the company, except when the meter has been found to be registering inaccurately or has ceased to register. In either case the meter will be promptly repaired by the company and the quantity of water consumed shall be estimated by the average registration of the meter on previous corresponding periods.

23. In case of a disputed account involving the accuracy of a meter, such meter shall be tested, upon the request of the consumer, in conformity with the provisions of the rules and regulations pertaining to Water Service Utilities of the Public Service Commission of the Commonwealth of Pennsylvania. In the event that the meter so tested is found to have an error in registration of 4 per cent or more, the bills will be increased or decreased accordingly as provided by the aforesaid rules.

24. Each request for the test of a meter for accuracy shall be accompanied by a deposit, the amount of which shall be determined by the size of the meter as set forth in the rules and regulations pertaining to Water Service Utilities of the Public Service Commission of the Commonwealth of Pennsylvania. If the meter so tested shall be found to have an error in registration of less than 4 per cent, the deposit shall be retained by the company as compensation for such test; if the error in registration is found to be 4 per cent, or more, then the cost of the test shall be borne by the company and the amount of the deposit shall be returned to the consumer.

25. The consumer shall at once notify the company of any injury to, or of any cessation in registration of, the meter as soon as it comes to his knowledge.

26. Each meter rate consumer is subject to a minimum charge, the amount of which is determined by the size of the meter as set forth in the schedule of rates.

Bills.—27. Flat rate service bills are due and payable quarterly at the office of the company on the first days of January, April, July and October of each year, covering service rendered during the previous three months.

28. Bills for water service for building purposes, are payable and due after service is rendered and upon presentation.

29. Bills for water service, under "general metered service" rates, will be rendered as soon after the first days of January, April, July and October of each year as it is possible to read the meters and make out the bills. Said bills will be for water consumed during the preceding three months and are due and payable upon presentation.

30. Bills for water service, under "metered service to extra large consumers, on night draft only," will be rendered as soon after the first day of each month as it is possible to read the meters and make out the bills. Said bills will be for water consumed during the preceding month and are due and payable upon presentation.

31. A penalty of ten (10%) per cent will be added to all bills for water service not paid within 15 days from the due date of the bill and if not paid within 30 days from the due date of bill, the water may be shut off upon five days' notice. Payments mailed, as evidenced by the United States post-office mark, on or previous to the end of the 15-day or 30-day period will be deemed to be a payment within such period. All bills will be made out in the name of the consumer whom the company will hold responsible for their payment.

32. Whenever the consumer desires to have his service contract terminated or his water service discontinued he shall notify the company to that effect in writing. The consumer will be responsible for the payment of all service rendered by the company until such written notice is received; and, in the instance of meter rate service, a reasonable time from the receipt of such notice shall have elapsed for the company to take the final reading of the meter or meters; or water service is actually otherwise discontinued by the company.

33. The presentation or non-presentation of a bill shall not be held to be a waiver of any of the above rules.

General.—34. The water may be shut off from a consumer failing to comply with these rules and will not be again turned on until satisfactory assurance is given that these rules will be complied with and all proper and necessary expense incurred in shutting off and turning on the water, are paid in full.

35. The company reserves the right to require a deposit in amount equal to the estimated billing period charges, to secure future payments where the credit of the consumer has not been established to the satisfaction of the company. Upon such deposits the company will pay interest at the rate of 6 per cent per annum, provided the deposit remains with the company for six months or more, and the company will return such deposit on notice to discontinue service and payment in full for all services rendered.

36. All waste of water is prohibited. A consumer shall keep his faucets, valves, hydrants, service lines and hose in good order and condition at his own expense. Sprinkling of any kind whatever must be done with ordinary spraying nozzles generally in use.

37. The water will, after due notice, be shut off from a consumer allowing it to run to prevent freezing, or allowing it to run to waste, and will not be again turned on until satisfactory assurance is given that the practice will be discontinued and all proper and necessary expense incurred in shutting off and turning on the water are paid in full.

38. When premises will be temporarily unoccupied, the consumer shall notify the company in writing and the water will be turned off and all charges will cease from that date. When the property is again occupied the consumer shall again notify the company in writing and the water will be turned on. No refund or allowance will be made for unoccupied property when written notice, both at time of vacancy and at time of occupancy, has not been given as above provided. No refund will be allowed for property unoccupied for a period of time less than one month.

39. In cases of vacancy of a consumer's property, the consumer must notify the company in writing of such vacancy, and upon his failure so to do he will become responsible for any damage to the property of the company, arising from such failure.

40. Water shall not be turned into any premises, by any person not an agent of the company, except temporarily by a plumber to enable him to test his work, provided it shall be turned off again immediately after the test is made.

41. The authorized agents of the company shall have the right of access, at all reasonable hours, to the premises supplied with water for the purpose of reading meters, examining pipes and fixtures, observing manner of using water, and for any other purpose which is proper and necessary in the conduct of the water company business, and will carry with them proper credentials denoting their employment by the company.

42. The company will not be liable for any claim or damage arising from a shortage of water, the breaking of machinery or other facilities, or any other cause beyond its control.

43. As necessity may arise in case of break, emergency or other unavoidable cause, the company shall have the right to temporarily cut off the water supply in order to make necessary repairs, connections, etc.; but the company will use all reasonable and practicable measures to notify the consumer,

in advance, of such discontinuance of service. In such case the company shall not be liable for any damage or inconvenience suffered by the consumer, nor in any case for any claim against it at any time for interruption in service, lessening of supply, inadequate pressure, poor quality of water, or any cause beyond its control. The company shall have the right to reserve a sufficient supply of water at all times in its reservoirs to provide for fire or any other emergencies and may restrict or regulate the quantity of water used by consumers in case of scarcity, or whenever the public welfare may require it.

44. Water from hydrants or other protection systems shall be used only in case of fires, except that water from public fire hydrants may be used, in a reasonable amount and at such times as the company may permit, for the purpose of testing the hydrants and the fire fighting apparatus of the Borough of Snow Shoe, such tests to be conducted only by the properly authorized agents or employees of said borough and after the consent of the company has been obtained.

45. No consumer, unless specially authorized to do so, shall open or close any of the company's stop cocks or valves in any public or private line.

46. No agent or employee of the company shall have the right or authority to bind it by any promise, agreement of representation contrary to the letter or intent of these rules and regulations.

47. The company reserves the right to alter or amend these rules and regulations in the manner provided by law.

Definitions.—48. The word "company" as used herein, shall mean the Snow Shoe Water Company acting through its properly authorized officers, agents or employees, each acting within the scope of the particular duties entrusted to him.

49. The word "consumer," as used herein, shall mean the party contracting for a supply of water to a property as hereinafter classified, i. e.:

(a) A building under one roof and occupied as one residence or business; or

(b) A combination of buildings in one enclosure and occupied by one family or business; or

(c) One side of a double house having a solid vertical partition wall; or

(d) One side or part of a house occupied by more than one family or business, even though the closet and other fixtures be used in common; or

(e) Each apartment, office or suite of offices located in a building having several such apartments, offices or suites of offices and using in common one hall and one or more means of entrance.

50. Each consumer will be supplied through a separate service line and, if on a metered basis, through a separate meter, except in cases (d) and (e), as above defined, in which cases each family, office, suite of offices or business shall be considered a separate consumer even though supplied through a common service line or meter.

Hackensack Water Co. Abolishes Collectors

The Hackensack Water Co. no longer uses collectors. A new system of collecting water bills, replacing the old and outworn method of personal visitation, has been adopted, it is announced by the president of the company, Nicholas S. Hill, Jr. This departure, Mr. Hill explained, respects both public integrity and sound business practice.

"Supplying water for domestic and industrial uses is a commercial enterprise fairly comparable to retail merchandising," he said. "In modern business very few merchants collect their bills by regularly sending collectors to their customers. The majority of householders meet their obligations promptly, and object to calls by collectors.

"Naturally water service has its credit problems, but these the company is solving through a procedure that is neither harsh nor arbitrary but rather invites a frank response from all classes of the community.

"In general the company believes that most of its customers wish to pay their bills with reasonable promptness, in their own way, at the company offices.

"An added convenience for customers is the cooperation of local banks in communities which are some distance from one of the company's district offices. There are 23 such banks at which water bills may now be paid, and each customer is told where the bank most convenient to him is situated. Last quarter 8 per cent of the bills were paid at neighborhood banks.

"If a bill is not paid within the period usually allowed as reasonable by business houses, the customer receives a statement or a notice from the company. In most cases the response of customers to this statement is prompt.

"An investigator may be sent to call upon a customer if there are any unusual matters reported in connection with the account or with the service.

"However if no word or payment is then received from a customer, he will receive in due course a letter from the company's attorney. Then, if finally necessary, suit will be started."

The chief advantages of the new system, according to Mr. Hill, are:

First, that under a regular schedule of dates every customer has ample time in which to pay his bill or to communicate with the company.

Second, no unnecessary or annoying calls are made at customers' premises.

Third, the old system of cutting off service has been stopped in all cases except where every other method of inducing a customer to pay for service received has been tried and has failed.

"This company," Mr. Hill added, "believes that water service is vital to all persons, and that to discontinue such service is too harsh a procedure except in the very few extreme cases now arising.

"Our customers who think this matter through know that anything which makes enforced collection of accounts neessary is a source of annoyance and additional cost both to the customers who do not pay and to the company.

"Our experience so far, and the reports from other places where the present system has been in effect for some years, show that the new way is receiving favorable comment and support from the people."

Sewage Treatment at Columbus, O.

The following is extracted from the 1929 report of the Division of Sewage Disposal, C. D. McGuire, Chemist in Charge, of the city of Columbus, O.:

"The treatment works operated 187 days and treated 5,604 million gallons, or practically 30 million gallons of sewage per day. This is a 50 per cent overload based upon the volume for which the filters were designed and about 100 per cent more than they will treat successfully based upon the present stream flow conditions, past experience and present requirements of the State Health Department.

"The tanks removed 80 per cent (by volume) of the settleable material and 53.4 per cent (by weight) of the total suspended solids from the raw sewage. The retention period in the tanks was 3.9 hours and they reduced the biochemical oxygen demand 30.6 per cent.

"The sprinkling filters retained 17.8 per cent of the suspended solids applied (5.7 less than in 1928), decreased the biochemical oxygen demand 60.1 per cent and produced 3.0 parts per million of nitrogen as nitrites and nitrates in the effluent. The mean dose per acre was 0.12 m.g.d. higher than in 1928, but the filters were in service 2.3 per cent less of the time. The mean rate of dose per acre was 4.43 m.g.d. and was 0.28 m.g.d. higher than for 1928.

"The whole system reduced the total suspended solids 61.8 per cent and the biochemical oxygen demand 72.4 per cent.

"During the year the procedure for making the routine biochemical oxygen demand test was modified as follows: First, the dilution water was made up by dissolving 500 p.p.m. sodium bicarbonate in tap water which has stood at least 5 days at laboratory temperature and then placing this in a 37 deg. incubator until required for use. Second, the samples were incubated submerged in a bath of water at 20° C. These modifications have given a decided increase in the number of check results obtained by the test."

SEWAGE DISPOSAL WORKS

A Section Dealing with Their Design, Construction and Operation

Conducted by JOHN R. DOWNES, Associate Editor

Supervising Engineer, the Plainfield and Dunellen, N. J., Sewage Disposal Works

Two Questions on Sludge Digestion Answered

Is it necessary to use pumps to circulate the heating water through the coils used to maintain the temperature in sludge digestion tanks, or will the water circulate automatically by the difference in temperature as in the case of a house heating plant?

The water will circulate automatically by reason of the thermal difference, but it is preferable to use pumps in order to secure equivalent heat transfer at lower initial water temperature.

The reason for keeping the initial temperature down is to prevent baking sludge on the outside of the heating coil since such a coating will interfere with heat transfer.

There has been considerable talk about this insulating coating forming on the heating coils, but little positive information on the subject has been available, heretofore. Recently the writer has had the opportunity of inspecting two circular digestion tanks which had been heated by means of thermal circulation without the use of circulating pumps. Both tanks had been in use for some 3½ years and the conditions in the two were so nearly identical as to establish a valuable check on actual conditions.

There was 110 ft. of pipe in each coil and the initial temperature of the heating water was approximately 140° F. The water returning at the temperature of the sludge in the tank showed that the heat had all been absorbed.

The above conditions were maintained during all of the 3½ years during which the tanks had been in continuous operation, but when the sludge was drawn off for inspection it was found that at the "hot end" of the coil there was a coating or shell 5/16th in. thick which could be cracked off in rather large pieces and resembled a clinker cement. The thickness of the coating gradually diminished to zero near the "cold end" of the coil, all evidence indicating that formation of the scale had been progressive and dependent on the higher temperatures for its formation.

The outer surface of the scale was so irregular as to preclude accurate measurements but it may be said that roughly the thickness was 5/16th at the "hot end" 4/16th at a point 20 ft. from this end, 3/16th at 40 ft., 2/16th at 60 ft. and 1/16th at 80 ft. Beyond this point it dwindled off rapidly.

Several conclusions may be drawn from the facts observed: In the first place, it appears from the fact that at the end of the 3½ years the cold water returned at sludge temperature that the heat transfer was complete in spite of the fact that not more than 30 ft. of the coil still remained uncoated to an appreciable extent.

It would appear that the usefulness of the coil as a heating element would be eliminated in from 7 to 9 years by the progressive growth of the scale.

Had the initial temperature of the water been kept down around 110° F. or possibly a little higher there would have been very little baking on of the sludge. The same heat transfer could have been accomplished at the lower initial temperature by more rapid circulation of the heating water by means of pumps.

During the early studies of heat controlled digestion, this matter of heat transfer through heating coils was studied by the writer and it was found that, since the heating of the water is regenerative, high initial temperature of the heating water is not essential and speed of circulation within reasonable limits is not critical.

That is to say, the heating unit simply makes up the difference between the temperature of the water from which the sludge has absorbed the heat and the initial hot water temperature. An apt illustration of this point is afforded by data (Table I) from the investigation mentioned.

Table I

Minutes required for circulation through heater and heating coil	7	9	11	9
Initial temperature of heating water	105	105	105	120
Temperature of returned water	87	80	75	89
Difference in temperature Initial to final	18	25	30	31

Since the total circuit consists of the coils in the boiler for heating the water and the coils in the sludge (which cools the water), a longer period of time in one means a relatively longer time in the other and the processes of cooling and reheating balance up within reasonable limits. Where the fuel is gas and the temperature of the heating water is thermostatically controlled there seems to be little difference in economy.

The work described above was carried on with a rather inefficient second-hand hot water boiler of the shell type and a grid of 1¼-in. pipe 140 ft. long. From the results of the work it was determined that a coil of 2-in. approximating 110 ft. in length would suffice to heat a sludge tank of 20,000 cu. ft. capacity, or a single turn of pipe about the interior of a 38-ft. diameter tank. Many engineers have expressed surprise at the small amount of heating pipe used, but it has proved very effective.

A test of the heating coil in place before sludge was introduced into the tank gave additional enlightening data. Working without circulating pumps and depending on thermal currents for circulation we ran two series of tests, one with initial temperature of 154° F. and the other with initial temperature of 137° F. The tank cover was resting on legs about 5 ft. from the tank floor at the periphery of the tank so that in effect we had a circular room 38 ft. in diameter and an average of 6 ft. 6 in. deep. Within this space the air temperature was 83° F.

Starting with an initial temperature of 154° F. we found as we progressed around the coil, a temperature of 190° F. 40 ft. from the hot water end, 89° F. 80 ft. from the hot end; running off to room temperature 100 ft. from the beginning.

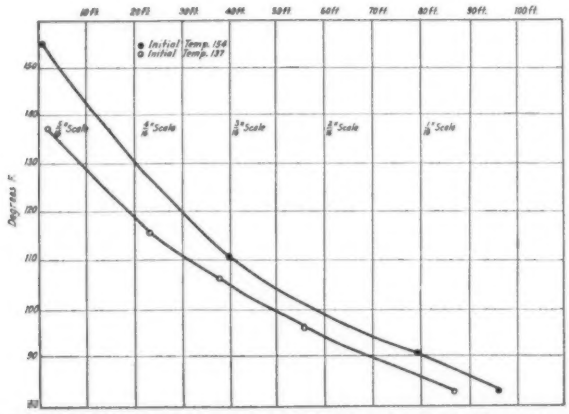
Starting with an initial temperature of 137° F. we obtained 116° F. at 22 ft.; 105° F. at 38 ft.; 95° F. at 55 ft. and room temperature about about 80 ft.

Note that room temperature—83° F.—approximates the optimum temperature for digesting sludge—82° F.—and that any lower temperature would absorb the heat more quickly; also had the coil been immerged in liquid, or sludge, the cooling would have been more rapid.

The attached graph indicates the conditions found in the two tests and also indicates the thickness of crust on the heating coil after 3½ years of service. The thickness of scale at any

point does not correspond to the indicated temperature but to some higher temperature, since the high temperature was carried forward in the pipe progressively as the insulating scale formed at the hot end.

Indications are that the provision of



Temperatures at Various Points in 2-In. Heater Coil in Digestion Tank (Room Temperature 83° F.)

110 ft. of 2-in. pipe for heating a tank of 20,000 cu. ft. capacity is ample; such a coil would serve its purpose for from 7 to 9 years at least, even if initial temperature of the heating water were as high as 140° F. before the incrustation on the pipe would seriously interfere. With initial temperatures as low as 110° F. and possibly as high as 120° F. the incrustation would be of no practical importance.

Delving into old records to answer the question in hand I find other interesting data which may as well be presented in this connection.

The "Digestion Tank" was simply an excavation 50 ft. square and 10 ft. deep, giving a total capacity of 25,000 cu. ft., and insulated by a cover of 2-in. pine planks. Without heating, the sludge temperature took exactly the same course as that in the digestion compartment of the Imhoff tanks, holding at 68° F. through the first week in October and dropping to 66° F. at the end of the month. By the end of November it was at 62½° F.; at the end of December it was 58° F. and the end of January 52½° F. By the middle of February it had reached a minimum of 50° F., where it remained until the 22nd, when heat was applied by means of the 140-ft. coil of 1¼-in. pipe.

From the time that we began to apply heat the temperature rose ½ deg. per day throughout the 24 days of the test. An average of 151 lb. of soft coal was used daily and 24 lb. of ash was removed daily, making the equivalent of 127 lb. of coal actually burned.

To raise the contents of the tank—25,000 cu. ft.—1° F. daily would require enough heat to raise 1,562,500 lb. of sludge 1 deg. daily.

Records of the differences in temperature in the heating water together with a calculation of the total flow of heating water passing any given point in the heating system daily indicate that the heat transferred was equivalent to raising 1,061,000 lb. of water 1 deg. per day.

Since 1,562,500 lb. of sludge were actually raised ½ deg. daily, equal to 781,250 lb. 1 deg. daily, we have the direct comparison on a practical scale of 1,061,000 deg.-lb. per day available —to 781,250 deg.-lb. actually corralled at the end of the 24-day period. The difference represents the losses of heat to ground and air. These losses equal 26.4 per cent.

It should be remembered that the sludge was in direct contact with the earth, there being no concrete or other retaining wall, and that the plank cover, floating on the surface of the sludge, did not completely cover the latter, as the earth cut was somewhat sloping, leaving 2 to 3 ft. of the surface exposed all around the edges. Undoubtedly a coating of lard-like grease from 1½ to 2 in. thick, which formed on the under side of the planks, aided in the insulation.

The attached graph indicates the air temperatures as well as the sludge temperature during these tests.

What pitch do you consider necessary for the floor of digestion tanks in order that solids will not lodge and take up valuable space?

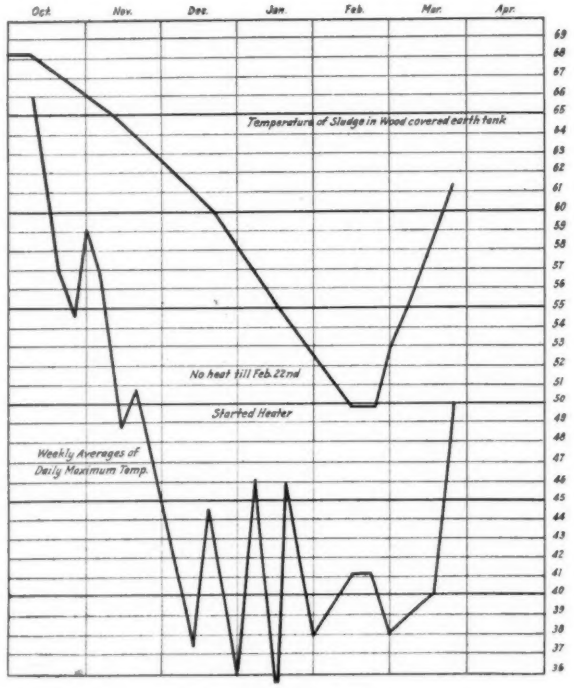
The answer depends on the sewage and the preliminary treatment and on what kind of a digestion tank you mean.

With sand and grit in a sewage it has been claimed that 60 deg. slopes are necessary. I have experienced difficulty with sand and grit collecting in Imhoff tanks where the slope was 1 vertical on 2 horizontal and when the preliminary treatment was not effective.

On the other hand working with separate digestion tanks under controlled conditions and where grit has been removed by screens and grit chambers I have experienced no difficulty, whatever, with a slope of 18 in. in 19 ft.

With heat controlling digestion gassing of the sludge is very active and gas lifted solids tend to be discharged near the gas dome where the ebulition is rather violent and to sink into quieter waters below. It takes but little strategy to place the sludge outlet beneath the gas dome and there you are.

The modern practice of installing screens and grit chambers in nearly every plant calls for a reconsideration of our old notions about the necessary slope, especially as steep slopes call for deep excavation and run into money. It is well to give consideration to the relative cost of grit chambers which allow of much less slope in the diges-



Data on Heating Sludge

tion tank floor. Even with strictly domestic sewage grit chambers should be given consideration and will usually be found economical.

In the case of two tanks recently examined which had been in service for 3½ years preceded by a fine screen and part of the time by a grit chamber, soundings revealed not more than 3 in. of loose grit on any part of the floor. This was so loosely packed that a rod or pipe penetrated easily to the concrete floor of its own weight. On drawing down these tanks after the 3½ years' service we found less than a yard of material which did not go out with the sludge, although the tanks had a capacity of 20,000 cu. ft. each and had treated an average of 400 cu. ft. of fresh sludge daily during the entire period of operation. These were the tanks mentioned above as having a slope of only 18 in. in 19 ft.

Annual Meeting New York State Sewage Works Association

The second regular annual meeting of the New York State Sewage Works Association was held in Albany, N. Y., on May 10. In the absence of the president, Kenneth Allen, the vice-president, C. A. Holmquist, presided. Sixty-one members and guests were present.

The morning session was devoted to the regular business of the association and to the presentation and discussion of two papers, one on "Operating Experience at the Syracuse Treatment Works," by W. P. Gyatt, chief operating engineer, and the other on "Essentials of Operation and Control of Small Sewage Treatment Plants" by C. C. Agar of the State Department of Health.

Wellington Donaldson (New York City), W. A. Ryan (Rochester) and C. L. Walker (Ithaca) were elected members of the executive committee for a term of three years to succeed the retiring members, R. Suter, R. H. Gould and Kenneth Allen. Mr. Allen, however, will continue to serve on the executive committee for another year as an advisory member. The officers for the ensuing year are C. A. Holmquist, president; Morris M. Cohn, vice-president, and A. S. Bedell, secretary-treasurer.

The report of the Committee on the Short School for Sewage Works Operators was received with considerable interest, as definite plans are being formulated for holding a one-week school at Schenectady during the coming autumn.

At the luncheon held in the DeWitt Clinton Hotel, Mr. C. A. Holmquist presented the greetings of Dr. Parran, the State Commissioner of Health, indicating his sincere interest in the aims and activities of the association. Following the luncheon, there was a lively round table discussion on the effect of industrial wastes on the operation of municipal sewage treatment plants, the propriety of allowing cellar drains to be connected to the sewer system and the specifications for house connections, led by R. S. Lanphear, R. C. Wheeler and Fred Fisch.

The meeting closed with an inspection trip to the sewage treatment plant of the city of Albany, and to the treatment works serving the Albany county buildings, where very complete treatment and odor control were well exemplified.

The next meeting of the association will be held on Sept. 6, 1930, in Syracuse, G. D. Holmes serving as chairman of the local committee on arrangements.

Treatment of Dairy Wastes

The Agricultural and Mechanical College of Texas, College Station, Texas, has issued recently a bulletin giving the results of a study of the treatment of dairy wastes, conducted by the Sewage Research Division of the Texas Engineering Experiment Station. The conclusions based on this study are summarize as follows in the bulletin:

Wherever possible a trickling filter rather than chemical methods should be used to treat dairy wastes. The advantages of the former methods are as follows:

(a) No preliminary treatment is needed except grit removal.

(b) Sludge and scum disposal is not a problem.

(c) A better effluent is obtained.

(d) Slight treatment can be given to prepare the waste for discharge into city sewers.

(e) A filter is more adaptable to fluctuations in the strength of the waste than is the chemical method.

(f) Skilled operation is not required.

(g) Operating cost will be slow.

A trickling filter 5 ft. deep operating at a 1.5 million gallon per acre per day or a filter 6 ft. deep operating at a 2 million gallon rate will produce a satisfactory effluent in the treatment of ordinary dairy waste (not including whey from cheese factories). At the 1.5 gal. rate a filter 3 ft. deep will give sufficient treatment for some purposes. (Note: These rates are based upon 24 hours operation per day. If the waste is discharged during 12 hours only the areadosage relationship must be changed accordingly.)

Sulphuric acid, alum, ferric chloride, and ferrous sulphate are of value (approximately in the order named) in precipating milk solids. With proper operation this method should produce an effluent suitable for discharging into streams or upon land without nuisance and without the necessity of chlorination. Sludge and scum will be a troublesome by-product, although that resulting from the sulphuric acid treatment could probably be used for feeding to hogs or chickens.

Supporting Strength of Concrete-Incased Pipe

The supporting strength of concrete-incased clay pipe as determined by the Iowa Engineering Experiment Station, Iowa State College, Ames, Ia., in cooperation with the Clay Products Association, Chicago, Ill., is reported in bulletin 93 of the experiment station.

It was found that the safe supporting strength of concrete-incased clay pipe is only slightly greater than the sum of the individual supporting strengths of the clay pipe and of the concrete incasement. The supporting strength of the incased pipe was found to be higher at lower temperatures. The action of an incased pipe is very nearly that of two independent but concentric rings, results indicated.

Tests indicated that the strength of a concrete specimen is influenced to a marked degree by the temperature at which it is tested. Specimens tested at 1° F. were found to have about double the ultimate strength of specimens made and cured under the same conditions but tested at 70° F.

Group Plan Insurance in Water Works Field.—Supervising Engineers, Inc., of New York City, a holding company for 42 water companies in the east and middle west has announced the expansion of its employes' group plan to include the benefits of $650,000 accidental death and dismemberment insurance combined with health and non-occupational accident insurance. The additional coverage is being underwritten by the Metropolitan Life Insurance Company. Individual benefits are based on salary, the dismemberment insurance ranging from $1,000 to $2,000 and the sick and accident benefits from $10 to $20 a week. These weekly payments will be made when an employe is unable to work due to sickness from any cause or injury received while off duty.

Reforestation by St. Paul Water Works.—Reforesting of the lands of the Water Department of St. Paul, Minn., continued during 1928 and 1929, work being confined mostly to replacements. Since 1914, when this project was started, there have been planted nearly 500,000 trees divided between White, Norway, Riga, Scotch, Swedish Scotch and Jack Pine; White, Norway, Red, Blue and Black Hills Spruce; White and Red Cedar and Balsam and Douglas Firs. While large numbers of trees have been lost from fire, theft and natural causes, a large percentage of the trees remain standing, some of the earlier plantings of Jack Pine having attained a height of 16.5 ft. in ten years. Jack, Scotch and Riga Pine have attained a height somewhat better than the average for these species throughout the Lake States.

Specifications for Drilled Wells

By W. SCOTT JOHNSON

Chief Public Health Engineer, Missouri State Board of Health, Jefferson City, Mo.

I WAS very much interested in the excellent article by Mr. Ferguson and Mr. Klassen on the "Sanitary Specifications and Construction of Water Wells," which appeared in the May issue of Water Works and Sewerage.

Five or six years ago many of the difficulties outlined in the above paper in securing satisfactory construction of well supplies were encountered in Missouri. Experience indicated that satisfactory specifications covering the sanitary features in well construction were of considerable aid in overcoming some of the difficulties. However, specifications covering all possible conditions to be encountered were not found practicable, since each well requires individual expert attention during its construction period. Granting that individuals in charge of drilling operations are thoroughly awake to the importance of proper sanitary well construction, there was still the factor of widely varying geological conditions encountered in Missouri which demanded expert technical supervision in order to assure safe and economical results.

In order to overcome this difficulty in the sanitary construction of well water supplies, a cooperative agreement was entered into between the State Board of Health and the State Geologist in 1925 that has proven most successful. Specifications were prepared covering the sanitary features of wells drilled in rock and the installation of well pumping machinery. All engineers are required to include these in specifications for the construction of municipal water supplies secured from wells. Copies of these specifications are enclosed.

In accordance with our agreement, the State Geologist is informed concerning a proposed well water supply and the driller is required to send a written notice to that office at least one week before operation is started. This gives the State Geologist an opportunity to advise with the driller concerning the probable conditions to be encountered, and also to supply a set of sacks for drillings and a drill record book. After drilling operations are begun the driller is required to secure cuttings from every screw, place same in sacks, label and send at once to the State Geologist. Also, all information concerning openings, fissures or soft or broken ground encountered is reported. From these data the State Geologist determines the depth at which it will be necessary to place the casing in order to exclude water of recent surface origin following solution channels and fissures in the rock. When the proper depth for setting the casing has been reached a field representative of the State Geologist inspects the job, supervises the sealing of the casing and checks the tightness of seal, as required by the specifications. After completion of the well all samples of cuttings secured after casing and the complete record book of log are forwarded to the State Geologist, who correlates same and furnishes the owner and the State Board of Health with a copy of the completed log of the well.

Upon completion of the entire job, including installation of the pump, etc., a final inspection is made by an engineer with State Board of Health to check for approval the sanitary features of the well top construction, including proper drainage of pit, if same is provided for, height of well casing above pit or pump room floor, well casing material, and the effectiveness of seal between drop pipe and casing. At this inspection samples are collected for bacteriological analysis at the State Board of Health laboratories and for complete chemical analysis by the State Geologist.

This plan has proven very successful in allowing for sufficient latitude relative to the depth of casing and at the same time to secure sufficient depth in order that shallow contaminated fissure water is excluded from the well supply. Incidentally, the data secured by the State Geologist has been of considerable value to him and has made it possible to prophesy the probability of securing a satisfactory municipal water supply from wells in many parts of the State. We believe that without this assistance from the State Geologist, particularly in setting the depth of casing, we can not be assured relative to whether or not this important point in the sanitary construction of a well supply has been properly provided for.

Recommended Specifications Covering Sanitary Features on Wells Drilled in Rock

1. **Samples of Cuttings.**—At least one week before starting to drill the well, the driller shall send a written request to the State Geologist, Rolla, Mo., who will furnish a set of small sacks and a drill record book. The well driller shall save a sample of cuttings from every screw and place same in the sacks, properly labeling same.

2. **Casing.**—The well shall be cased with a screw joint steel or wrought iron pipe installed in a watertight manner. The State Geologist will recommend the depth of casing advisable to effectively shut out contaminated surface water based upon available records. The casing shall be extended to at least this depth and deeper if necessary so as to case off all openings or soft or broken ground.

Where the water encountered is known or found to be corrosive, special provision shall be made to protect the casing from corrosion by a method approved by the State Board of Health; the contractor to receive extra compensation for same in an amount agreed upon in writing prior to undertaking the work.

The well casing shall be extended to a point from four or six inches above the elevation of the finished pump room or pump pit floor, and shall be provided with a thread at the top.

3. **Seal.**—A satisfactory seal shall be made or installed at the bottom of the casing, by one of the following methods:

a—Setting the bottom of the casing on a shoulder in the well made by reducing the size of the drill hole, and sealing with cement grout, a lead packer or drill cuttings of a cementing character.

b—Driving casing into clay, shale or similar sealing formation.

c—Installing an expanding rubber packer.

The seal shall be tested by bailing out the drill hole and making sure that there is no leakage into same over a period of forty-eight hours. When no appreciable amount of water has been encountered up to time of sealing, at least 1,000 gallons of water shall be run into the annular space on the outside of the casing to test the seal.

4. **Water Analysis.**—Where a water-bearing stratum, furnishing the required volume of water, is encountered at a satisfactory depth, samples of water shall be collected at the end of the test pumping run and submitted to the State Geologist or private chemist for complete chemical analysis, including the iron, manganese, and hardness content, to determine the suitability of the water for a general city supply.

5. **Records.**—The driller shall note in the drill record book the location and depth of any openings or soft or broken ground encountered, together with complete information on the depth of casing, method of sealing same, and result of test of seal.

Immediately on completion of the well, and prior to completion if requested, the driller shall forward all samples of cuttings and the drill record book to the State Geologist, who will correlate same and furnish the owner with a copy of the completed log of the well.

6. **Approval.**—These specifications shall be carried out in a manner satisfactory to the State Board of Health of Missouri, before this portion of the work is accepted.

Recommended Specifications Covering Sanitary Features in the Installation of Well Pumping Machinery

A. The use of a well pit or sub-ground level pump room shall be avoided wherever practicable on account of the possibility of stoppage of the drain or ejector and neglect to replace the well top seal after making repairs.

B. Where the pump is installed without a pit—

1. The pump shall be installed on a concrete base of sufficient height to permit the outside casing to extend at least 4 inches above the pump room floor, and to enable the installation of a suitable connection as noted under B-2.

2. The annular opening between the outside casing and pump column shall be closed by means of a suitable watertight connection which will effectually prevent waste water, oil, insects or other contaminating material from entering the well.

C. Where the pump is installed with a pit or in a pump room below the ground level—

1. The sides and bottom of the pit or pump room, below the ground level, shall be constructed of watertight concrete. The pit shall be left uncovered to permit easy inspection by the pump operator, and shall be surrounded by concrete curb at least 6 inches high and a pipe railing.

2. The annular opening between the outside casing and pump column shall be closed by means of a watertight connection capable of withstanding for 24 hours, without leakage, the water pressure resulting from complete filling of the pit with water. The types of connections approved are given below in order of preference.

a—An all flanged or threaded connection.

b—A stuffing box connection.

c—Metal to grouted cement connection with suitable gasket (not rubber); to be used only when joint carries weight of pump column and the pump is rigidly supported to prevent vibration.

Any vents provided for the well shall be extended by a pipe with screw or flange connections to a point above the floor level. A return ell shall be screwed on the upper end of this pipe, and screened.

3. Drainage shall be provided for the pump

pit or pump room by one of the following methods:

a—By means of a drain consisting of a sewer pipe, not less than 6 in. in diameter, with cemented joints, installed in a straight line and on an even grade of not less than 0.6 per ft. per 100 ft., with a concrete bulkhead at the outlet to insure an open discharge at all times; provided that under no conditions shall this drain receive sewage, or be connected to a sewer, and that the bottom of the pit so drained shall be above the high water level in any adjacent watercourse.

b—By means of a pump or ejector drawing from a sump of not less than 12 cubic ft. capacity situated so as to collect all waste water. This pump or ejector shall operate automatically or be connected to some moving part of the pump head, so as to operate continuously with this pump, and shall discharge above the pump room floor level into a suitable drain at a point safely removed from the pump pit or pump room.

4. The bottom of the pit or pump room shall be sloped away from the top of the well casing toward the drain or sump with sufficient grade to insure ready flow. At least six inches difference in elevation shall be provided between the top of the well casing and high water level in the sump.

D. A separate pump column, suction or discharge pipe shall be installed inside the well casing in all instances, whether the well is to be pumped by suction, air lift or deep well pump.

E. These specifications shall be carried out in a manner satisfactory to the State Board of Health of Missouri, before this portion of the work is accepted.

Canal Capacity Increased by Concrete Lining

The Sewage and Water Board of New Orleans, La., recently completed lining with concrete the Metairie Relief Canal. The work included the construction of a 6-in. cast-in-place sloping bottom, in some places resting on the wooden piling and wooden floor of the old lining, the casting and driving of a concrete sheet-pile wall and the building of many concrete structures which carry streets over the canal.

The work was done to increase the drainage capacity. Ordinarily that would mean the deepening and widening of the canal. But in New Orleans deepening a canal would enormously increase the infiltration and also the trouble with unstable banks. As all drainage water in New Orleans has to be pumped at least once it seemed better to get increased drainage by lining

Sheet Piling Was Driven by an Ordinary Steam-Hammer Pile Driver

the canal with concrete to speed up the flow by decreasing friction.

The Metairie Canal widens and deepens as it approaches the outlet, so its cross-section is variable. A typical section is 87 ft. wide with flood elevation at 22.87 and invert elevation 9.83. The mean gauge level of Lake Ponchartrain, the outlet for the canal, is 21.26 ft. The bottom section is 26 ft. wide and slopes from sides to center, 3 ft. in 13 ft. It consists of two slabs, 6 in. thick, reinforced with ⅝-in. round rods spaced 6 in. center to center in both directions. It rests on the old wooden canal lining of planks, wooden caps and wooden piles.

The next section on each side of the center is 13½ ft. wide and slopes 0.75 ft. in that distance. It is 6 in. thick and rests on the earthen side of the old canal.

The outer sections are 16 ft. 4 in. in horizontal section and rise 8.17 ft. in that distance, making a slope of 2:1. Each section was cast separately and is separated from sections above and below by a ¾-in. expansion joint, designed to prevent infiltration.

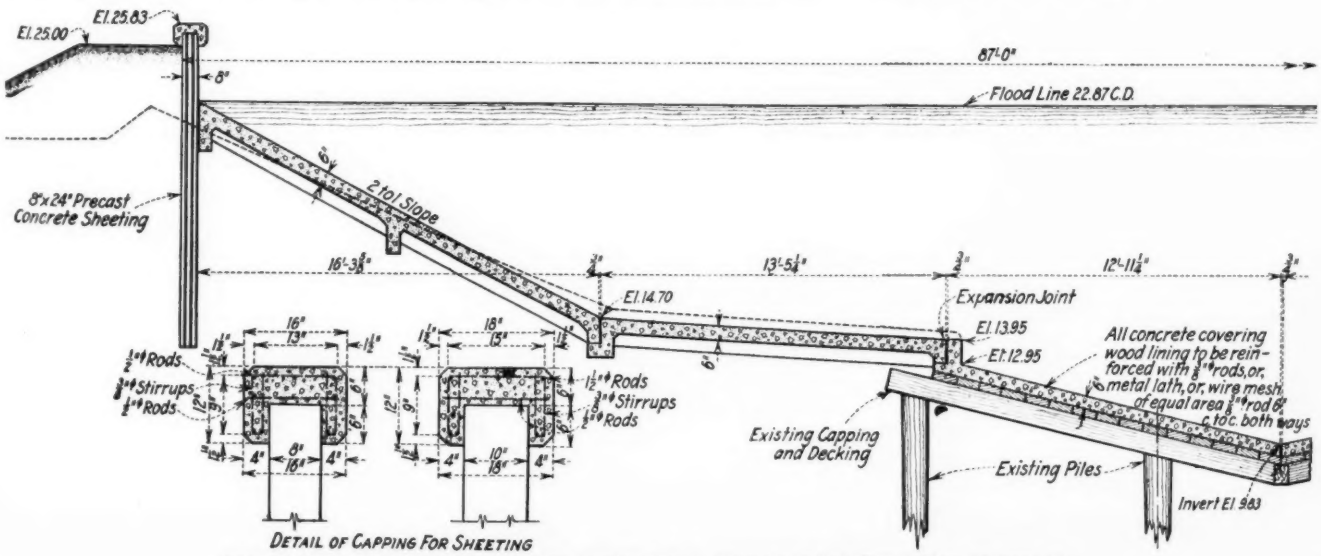
Precast concrete sheet piles form a retaining wall at the outer edges of the concrete lining.

Officials Pacific Northwest Section A. W. W. A.

Due to the fact that Mr. R. F. McLean, who was elected secretary and treasurer of the Pacific Northwest Section of the American Water Works Association, declined to accept the office, the board of directors requested Ernest C. Willard to continue for another year. The corrected list of officers and directors of the section is as follows: Chairman, Alex Lindsay, Superintendent Water Department, Spokane, Wash.; vice-chairman, Carl A. McLain, General Superintendent-Secretary, Eugene Water Board, Eugene, Ore.; secretary-treasurer, Ernest C. Willard, Consulting Engineer, Portland, Ore.; director, Fred J. Sharkey, Superintendent Water Works, Wenatchee, Wash.; director, R. H. Corey, Division Engineer, Public Works Engineering Corporation, Salem, Ore.; national director, W. A. Kunigk, Superintendent Water Department, Tacoma, Wash.

New Orleans Building Three New Incinerators.—Three new incinerators to cost a total of $700,000 are under construction at New Orleans and will add appreciably to that city's sanitation system. This will make a total of five plants where garbage can be readily disposed of. The plants, according to Commissioner of Public Property John Klorer, will be equipped in the most scientific manner with special provision for the prevention of any smoke nuisance.

The incinerators are conveniently distributed about the city, one of the new ones being almost ready for use. The one now nearing completion can handle 170 tons of garbage every 16 hours with no odor escaping, and its stacks are 125 ft. high.



DETAIL OF CAPPING FOR SHEETING

Half of Typical Section Near Pumping Station No. 1, Metairie Relief Canal, New Orleans, La.

Training Operators for Small Filtration Plants

How the Bureau of Sanitary Engineering of North Carolina State Board of Health Has Helped Small Towns Solve the Problem of Securing Efficient Operating Personnel

By J. SUMMIE WHITENER

Associate Professor of Sanitary Engineering, North Carolina State College of Agriculture and Engineering, Raleigh, N. C.

The problem of securing and training operating personnel for small purification works confronts almost every small town. Some towns have solved this problem, while the majority are still working on it, and some even have not yet realized that they are faced with it. The excellent methods by which the Bureau of Sanitary Engineering of the North Carolina State Board of Health has helped the small town in that state solve the problem was explained by Prof. Whitener in a paper presented at the St. Louis convention of the American Water Works Association. An abstract of the paper is given herewith.

THE Bureau of Sanitary Engineering of the North Carolina State Board of Health was established in 1919. The first survey of water purification plants in 1921 showed a total of fifty plants, with one plant technically operated, and the necessity for a wholesale reconstruction and improvement program before much improvement in operation could be expected. This program was successfully carried out by using practically the same methods as have been used in obtaining better plant operation and more technical plant operators.

Obtaining Better Plant Operation.—The first step in obtaining better plant operation was the performance of service to municipal officials. Most officials serve for one or two years and in many instances they have no one to advise them as to their responsibilities in matters affecting public health. The bureau's engineers sought to advise them as to the extent of their responsibility, acquaint them with public health laws, and help them solve problems affecting public health. In a great many cases the engineers would roll up their sleeves and help repair equipment that was out of order, giving the plant a thorough cleaning, etc. This helped to convince the officials that these engineers knew what they were talking about and that they were willing to help carry out any suggestions that were made. Such tactics tended to educate and make friends of municipal officials from the mayor on down.

Training Non-Technical Operators.—The methods used in training all non-technical operators, while generally the same, varied in detail for each town and were applied alike to operators newly employed and those who were considered experienced operators. In every case an engineer spent from one to two weeks with the plant operator and instructed him in the proper operation of his plant and in the use of such laboratory equipment as had been provided. The plant was thoroughly cleaned and all equipment overhauled. In some cases this took a great deal of diplomacy on account of antagonism of either the operator or the superintendent, or both, as they looked on the engineer with suspicion, treating him as an inspector to be tolerated and got rid of as quickly as possible. In cases of this kind he spent only a few hours at the plant and, before leaving, called on the city officials and offered the services of the bureau if at any time they were needed. It was then the policy to wait until the town called for help in case of trouble or a sudden emergency. When such a call came an engineer would get on the ground in the shortest possible time, generally in a few hours, and advise the officials what to do and help them do it. He would stay on the job until the trouble was remedied or the emergency had passed. Then he would usually carry out the program of training the operator and cleaning up the plant before leaving. This method often brought better and more lasting results because of the service rendered and the friendly relations established.

In other cases, the operator and the superintendent co-operated with the engineer in carrying out the program of training for the operator. Sometimes the superintendent would take advantage of this opportunity to learn more about plant operation himself, and if the plant needed additional equipment or laboratory apparatus, the superintendent would order it if he had the authority, and if not, the engineer would go with him before his board and back him up in his request. In every case it was very carefully explained to the officials that all parties concerned were handicapped by the fact that a non-technical operator could not take in all that the engineer was able to teach him.

This period of training was followed up from time to time to make sure that the operator understood all that had been taught him and that he had not fallen by the wayside and was neglecting the plant.

Training Inexperienced Technical Plant Operators.—When a technical man was employed by a municipality to operate its purification plant, an engineer was detailed for at least a week to operate this plant and gradually break him in, letting him assume more and more responsibility as he was able. The training of technical plant operators was carried out in the same way as that of non-technical operators, except that it took less time. The engineer was able to explain in detail the theory of water purification and plant design and feel that he was being followed and not wasting his time. The making of laboratory tests and their application to the control of operation was not taught in a mechanical and elementary way, as was done with non-technical men, but the significance and application of every test was explained in detail and understood by the technical operator.

When it was felt that the operator could operate the plant properly, he was left for a week or two and then a few more days were spent with him. During the time the engineer was not on the job the operator knew it advisable to call him back immediately if anything went wrong. In this way the town was not left to the mercy of an inexperienced operator, nor the operator to the mercy of the town. And at no time was the town supplied with unsafe water. This method made lifelong friends of the town officials and the operator, and was well worth the time and money spent.

Educating the Municipalities.—The first contact having been made and friendly relations established on a sound basis, the next step was to explain the necessity of technical plant supervision and that such supervision was not only the best possible insurance against unsafe water but that in almost every case it resulted in a material decrease in the cost of plant operation. As more technical men were employed, this statement was very satisfactorily proved. In some instances technical men saved as much or more than their year's salary in less than a year's time by reducing operating costs. This was done by the proper and frequent adjustment of chemical dosages controlled by laboratory tests, care and maintenance of plant equipment, etc., thereby cutting

down the repair costs and increasing the overall plant efficiency.

Another strong argument was that by employing a technical man who would make daily chemical and bacteriological laboratory tests and keep records of these tests, together with other necessary plant records, the town showed that it was providing the best possible protection for its water consumers against water-borne diseases. Plant records kept by a competent operator have been used in court for the conviction of persons polluting the raw water supply and as evidence to dismiss any suspicions as to the safety of the water supply in case of an epidemic which is later traced to another source.

In small towns it was pointed out that a technical operator with engineering training would be able to serve the town, in addition to his duties as plant operator, in the following ways:

1. As operator in charge of the sewage disposal plant he could make daily laboratory tests and control the plant operation by them. For the average small town sewage plant this would require but very little additional laboratory equipment to that already in the water plant. Records of sewage plant tests and operation are very valuable to the town in case of damage suits brought by property owners on the stream below the plant. With a properly designed sewage plant and technical operation, it is very hard to prove negligence on the part of the town. This helped to change the almost universal opinion that small sewage plants once built needed no operation and could be forgotten.

2. As milk inspector in both large and small towns that have passed the standard milk ordinance, he would be able to inspect the dairies and test the milk delivered in town. This gives the town a competent man to enforce the provisions of the standard milk ordinance. Taken separately, this job would cost the town at least $75 per month, but by combining it with the plant operator's job, it requires an increase of only about $25 a month in his salary, plus travel allowance to and from the dairies.

3. As assistant to the superintendent of water works, city engineer or city manager, he could make accurate maps of the water and sewerage system, keep these maps up to date, and solve many small engineering problems that are always coming up and are not large enough to justify the employment of a consulting engineer. This additional service coupled with the reduction in plant operation costs would more than justify his salary.

4. As superintendent of water works in towns that had enough plant capacity and clear water storage so that the plant could be operated a few hours each day or every other day and supply the demand. The salary for the combined job has in some cases been less than that of a non-technical superintendent.

5. As a final argument, it is pointed out that a non-technical man of the type usually employed as operator, such as garage mechanic, one familiar with steam engines, pumps, etc., would cost the town at least $100.00 per month, but, not having the education and basic training, he could not take in all the bureau's engineers might teach him, and, therefore, could go only so far in the field of plant operation. On the other hand, a technical man can be secured for a salary around $125 and would be able to develop initiative of his own and become of very much greater value to the town.

Locating a Technically Trained Man.—It was quite natural that after having convinced a municipality of its need for a technically trained man the question arose: "Do you know where we can get a good man?" or "Can you get us a good man?" The answer was that not one but several men would be located who could be recommended on the basis of their training and experience and that it would then be up to the town to employ the one that suited them best. When a man is employed an engineer spends whatever time is necessary in teaching him how to operate the plant and check up on his work from time to time to see that the town is getting the type of plant operation it is paying for. If it is found that this is not the case, the engineer will advise the town and recommend that it get another man.

In the first few cases, men with training and experience in plant operation were secured from other states. These men were for the larger towns that could afford to pay them enough to justify a change. The bureau then turned to the list of graduates from the North Carolina State College of Agriculture and Engineering and from the University of North Carolina and found that neither college had a curriculum in sanitary engineering, but that graduates in civil engineering or chemistry could be used and that positions as plant operators were attractive to them. In nearly every case the starting salary was $125 per month. The supply has been kept ahead of the demand between periods of graduation by recruiting men who had started out in other branches of engineering or chemistry, having become dissatisfied and desired to make a change.

Relation of a Plant Operator to Municipality and to Bureau of Engineering.—The operator, as was stated before, is employed and paid by the town. It was explained to him that his recommendation was based on his technical training and on the belief in his ability to do the work. He understands that he is to be helped in every possible way and it is assumed that he will be conscientious and take an interest in his work. He also understands that if he becomes careless or lazy and does not operate the plant properly, he is endangering public health, and drawing a salary which he does not deserve, and that the town will be acquainted with the facts and advised to employ another man.

Monthly Reports.—Monthly report blanks are furnished to both water purification and sewage plant operators. These reports have columns for all necessary plant operation data, cost data and results of chemical and bacteriological laboratory tests. These data are entered on the report daily and at the end of the month the report is totalled and averaged. This report is kept in the plant and two ink copies are made, one for the superintendent of water works or sewage works and one is sent to the bureau of sanitary engineering at Raleigh. When these reports reach the bureau's office, they are carefully checked for mistakes in calculation, poor plant efficiency, or improper operation. Such errors are called to the operator's attention by letter or by a visit from one of the engineers.

Field Inspections.—Routine inspections are now made of each plant once a month. The number of inspections made of any one plant varies according to the number of engineers available and to the character of the plant operation. In making an inspection, if the engineer finds anything wrong he calls it to the attention of the plant operator and discusses with him the best method of correcting the trouble. In case additional equipment is needed, he goes with the operator to the superintendent and backs up the operator's request. If necessary, an official letter to the town board is written recommending the additional equipment. In this way the operator feels that an inspection of his plant is made not for the purpose of criticising his operation but to make suggestions that might improve the operation and help him solve any problems that have been troubling him. This method, besides giving a true picture of the operation of each plant, keeps the engineers on very friendly terms with the operators and superintendents and promotes the best kind of cooperation.

Investigation and Research.—In case serious trouble is reported by an operator, an engineer is detailed to spend whatever time is necessary for investigation and research, to locate the source of trouble and to help the operator work out some method of correcting it. Recently the manufacturers in a small town complained to the bureau about the excessive scale formed in boilers using water from the town purification plant. This plant did not have a technically trained operator and the town officials had been perfectly satisfied until they were rudely awakened by the manufacturers. Just at this time the plant operator was acci-

dentally killed and the town called for assistance. An engineer was sent to operate the plant and to locate the cause of the boiler scale. It was found that the scale was caused by improper adjustment of chemical dosages at the plant and a recommendation for the employment of a technical operator was acted on at once. By operating this town's plant for two weeks the manufacturers were given relief from excessive boiler scale and convinced of the fact that they needed a technical operator.

Advancement to Better Positions.—In the case just mentioned, the technical operator had been running a plant in a smaller town for about four months at a salary of $125 per month. Prior to that he had been in a city engineer's office making $150 per month, but saw no chance for advancement and decided to change to sanitary engineering. The second town paid him $150 per month, so in four months he had changed from one branch of engineering to another and was receiving the same salary. Since then he has accepted the position as plant operator in a larger town and is in line for the position of superintendent of water works. This is a typical case and is used as a very good argument in getting technical men to accept positions as plant operators.

Advancement in any case depends on the ability, initiative and conscientiousness of a plant operator. When an opening occurs in one of the larger plants, an operator with experience at a smaller plant is usually given the position and in some cases three or four men are advanced to better jobs with more salary, and an inexperienced technical man is started in on the smallest plant.

Before recommending an operator already employed by one town to another town, the officials in the first town are always consulted and advised of the proposed recommendation of their operator for employment by another town. If the operator is receiving the maximum salary the town is able to pay and the second town is willing to pay more, the change is generally made, and the first town employs another operator with less experience at a smaller salary. If the operator is not receiving the maximum, his salary is frequently raised by the first town in order to keep him. Operators have often had their salaries increased without knowing until afterward that a recommendation had been contemplated. The bureau in all cases is governed by what is fair to both the town and its operator and all parties concerned have realized that it was interested in securing the best possible plant operation for every town in the cause of public health.

The bureau has had a great deal of trouble in keeping the personnel of its own organization because the larger towns, realizing the type of training its engineers receive, are willing to pay them more as plant operators than they receive as engineers. It has lost one man to another state because that state doubled his salary, another to the North Carolina State College and one to the University of North Carolina. Both institutions now have courses in sanitary engineering, and the two men became professors of sanitary engineering at these colleges. When a man leaves the organization to go with a town or a college the bureau does not consider that it has lost a man, but rather that another good technically trained operator or college professor has been released who knows its policy and will help the state improve its public health.

Value of the North Carolina Section A. W. W. A.—The North Carolina section of the American Water Works Association has been the largest contributing factor in securing and maintaining technical supervision of water purification and sewage disposal plants. A majority of the members are water works superintendents and plant operators. Those superintendents and operators who are not members know that they are welcome to attend all meetings. That they do attend is proved by the fact that the number attending is always much larger than the membership.

A separate conference of water purification plant operators was formerly held at the same time as the section meeting. Separate sessions were held because some of the older superintendents did not care to listen to long, detailed, technical discussions of filter plant problems. In 1928 the section voted to abolish this conference and to have all papers included in the regular section programs, because it was found that the attendance at these conferences was greater than at the regular section sessions. This was due to the increased number of technically trained superintendents and operators and to the changed viewpoint of the non-technical superintendents and operators.

Results.—The training of technical and non-technical plant operators has caused a general increase in plant efficiency and a general decrease in the total cost of filtration. Their better understanding of plant operation has helped increase the factor of safety against water-borne diseases. By the proper control of filtration with laboratory tests, plant effluents with a B. Coli index of zero are becoming common. Secondary lime treatment for red water control has become standard practice and prechlorination is being used in a number of plants to good advantage.

In one instance a technical operator worked out a treatment process for highly colored water. This process consisted of a primary dosage of chlorinated copperas and a secondary dosage of either sodium aluminate, or alum and lime added simultaneously. Another technical operator increased the length of filter runs, lowered the cost of operation and turned out a better effluent, by the chlorination of coagulated water.

Of the 78 municipal water purification plants in the state, 63 are in small towns and 28 of these plants are operated by technical men. Twelve of the 15 plants in large towns are technically operated. Three out of five institutional plants are operated by technical men. One town with a population of 1,147 has a technical operator who serves as superintendent of water works, looks after the sewer system, and operates the disposal plant.

Sewage plants are better operated because more of them are under the supervision of the water plant operator. More complete and accurate reports of the operation of both water and sewage plants are being kept. These reports are valuable to the individual towns and when compiled into yearly state reports by the bureau they become of even more value to the state as a whole.

The municipalities have been educated to the point where they realize the value of technically trained men as operators. This realization of their value has increased the demand for technical operators. Because it was found that graduates in civil engineering or chemistry were not properly fitted for sanitary engineering work, State College and the University have added sanitary engineering to their courses of instruction. State College now has a 4-year course in sanitary engineering and courses for graduate students.

This course is designed to prepare graduates for positions as technical operators to supply the demands of the municipalities.

Co-operation between the administrative agencies and educational institutions of the state has materially aided the rapid progress made in sanitary engineering and public health work. Such co-operation must be practiced in any state that expects to make much progress.

Town Has 7-Year Water Service Contract.—All applications for water service from the town of Monson, Mass., are now asked to contract to pay the regular water rent of $6 a year for seven consecutive years, whether they use the water or not, and the contract extends to their heirs and assigns. This rule has been adopted by the water commissioners in order to prevent any future misunderstandings. This covers the cost of tapping the main and conveying the water to the patrons' premises.

Chlorinated-Copper as a Coagulant

Recent Developments in Its Use at the Chickasaw, Ala., Filtration Plant

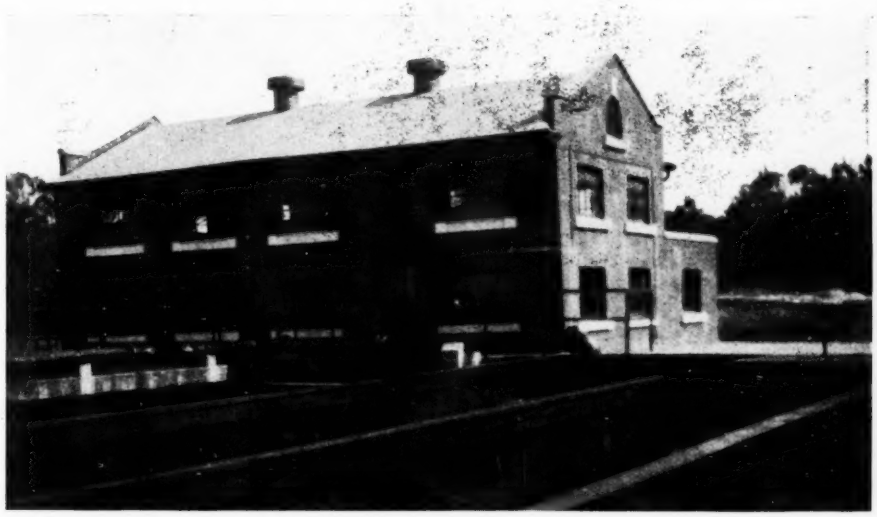
By A. CLINTON DECKER

Sanitary Engineer, Tennessee Coal, Iron & Railroad Co., Birmingham, Ala., and Chickasaw Utilities Co., Mobile, Ala.

EARLY in 1929, a series of experiments were undertaken by Mr. H. G. Menks, Assistant Sanitary Engineer, Alabama State Board of Health, and the writer at the Chickasaw, Ala., filtration plant. This plant is owned by the Chickasaw Utilities Co., a subsidiary of the United States Steel Corporation and was leased early in 1928 to the Alabama Water Service Co. to supply the towns of Chickasaw and Prichard and contiguous territory.

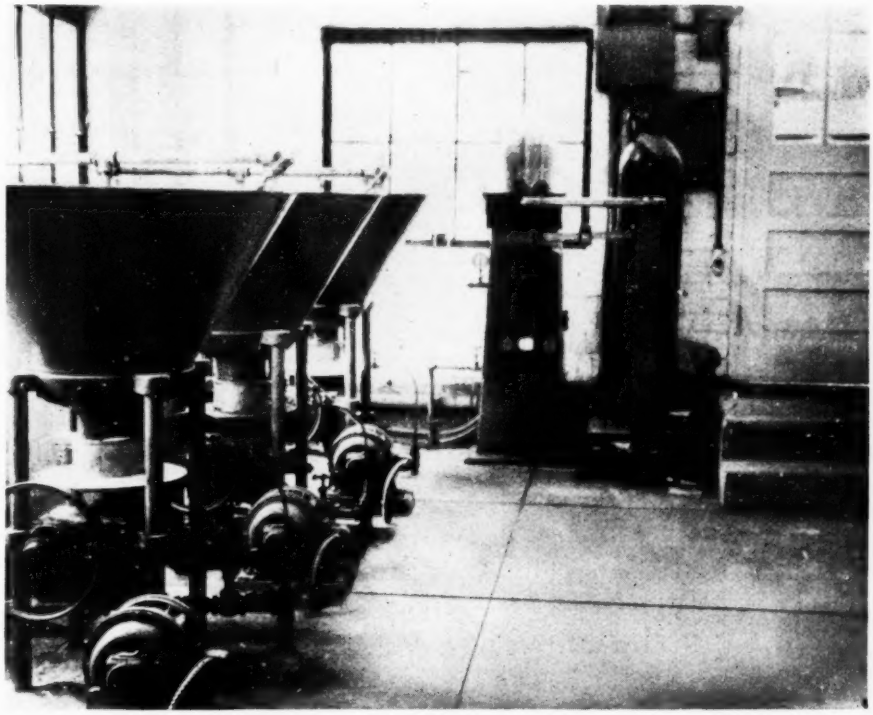
The Supply.—The source of supply for this plant is Eight Mile Creek. This stream originates in springs and flows through a heavily cypress wooded territory which imparts to the water a color normally ranging from 40 to 130 p.p.m. The alkalinity ranges from 2 to 5 p.p.m. and constitutes the total hardness. The turbidity is normally very low, ranging from 3 to 25 and on very rare occasions being as high as 50. The pH varies from 5.5 to 5.9. The bacterial content is normally under 100 per c.c. at 37½° C. Color removal constitutes the most difficult problem in connection with the treatment of this water. The first experiments which were made included the use of ferrous sulphate, alum, lime, and soda ash in various quantities and combinations. It was our opinion that the best results of coagulation and color removal were obtained when 3 grains per gallon of lime and 5½ grains per gallon of alum were used. The filtered water showed an alkalinity of 8, color 0, turbidity 0, and pH 6.4.

Experimental Work.—On the basis of these results, it was concluded that a treatment plant could be operated to produce desired results, and plans were prepared in accordance with recommendations made as a result of these experiments. After the plant had been designed and construction started, the possibility of the use of "chlorinated-copperas" was brought to our attention by Mr. L. H. Enslow, Research Engineer of the Chlorine Institute. Experimental work was then undertaken with this coagulant and further work done with coagulants previously used. It was found that best results were secured by using 0.7 of a grain per gallon of copperas oxidized by adding, in addition to the theoretically required amount of chlorine to oxidize the ferrous iron (1.5 p.p.m.), an additional amount sufficient to satisfy the chlorine demand of the raw water, making a total of 2.16 p.p.m. of chlorine applied to the copperas solution. There remained at the end of the mixing chamber 0.2 p.p.m. of residual chlorine. There had thus been produced simultaneously, copperas oxidation and prechlorination. In passing through the coagulating basins, the residual chlorine disappeared and water passing on to the filters showed no trace of chlorine. Although good coagulation was obtained with much smaller doses of "chlorinated-copperas" than 0.7 of a grain per gallon, the color removal was not complete except when the above amount was used.

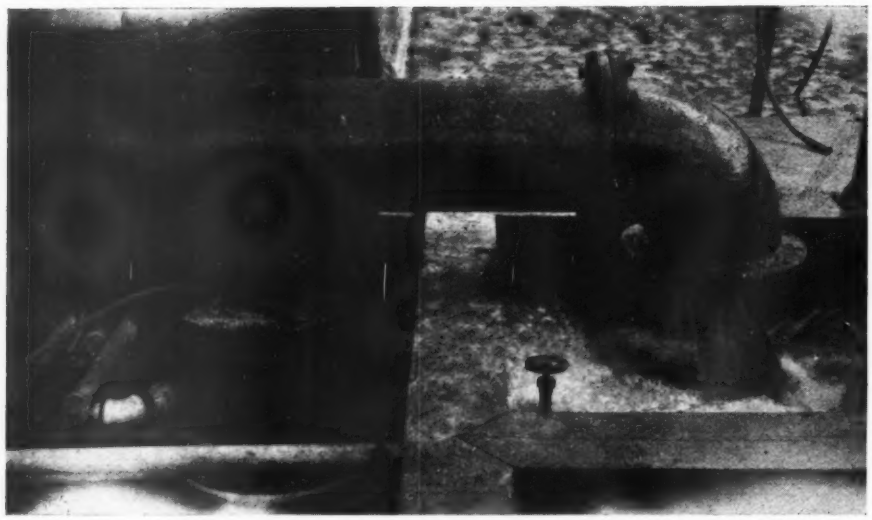


Coagulating Basins and Filter Building

"Chlorinated-copperas" is prepared by mixing a solution of ferrous sulphate ($FeSO_4:7H_2O$), commonly known as "copperas" and chlorine water from a chlorinator. The copperas may be fed



The Chemical Feed Machines



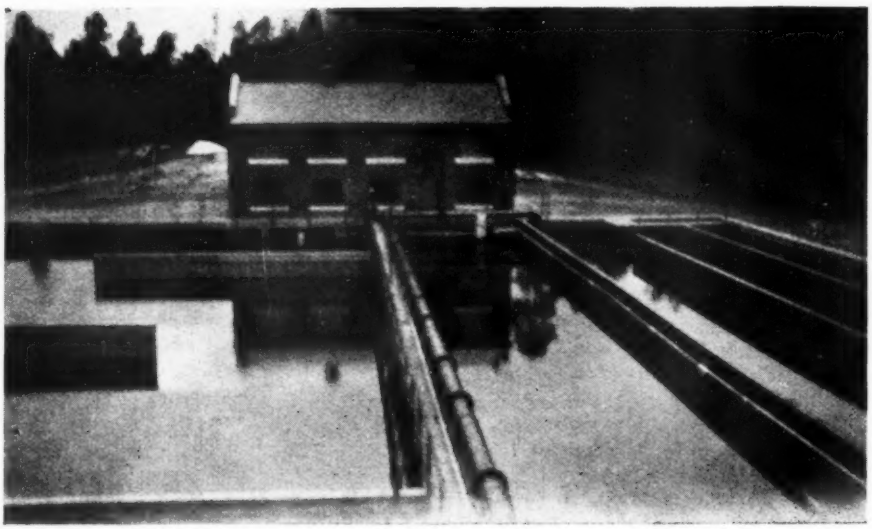
Barrel in Which Copperas Is Chlorinated

would be used, the equipment selected was Wallace and Tiernan Type "B" dry feed machines and Type "M.S.V." chlorinator. The mixing device used consisted of a 50-gal. barrel which was placed on a bracket immediately adjacent to the first compartment of the mixing chamber. The copperas solution line from the dry feed machine was so arranged as to lead into this barrel and discharge at a point near the bottom, causing a swirling action in the barrel. The chlorine was introduced through the chlorine discharge hose at a point near the bottom of the barrel. The "chlorinated-copperas" was discharged from an outlet pipe located near the top of the barrel into the mixing chamber.

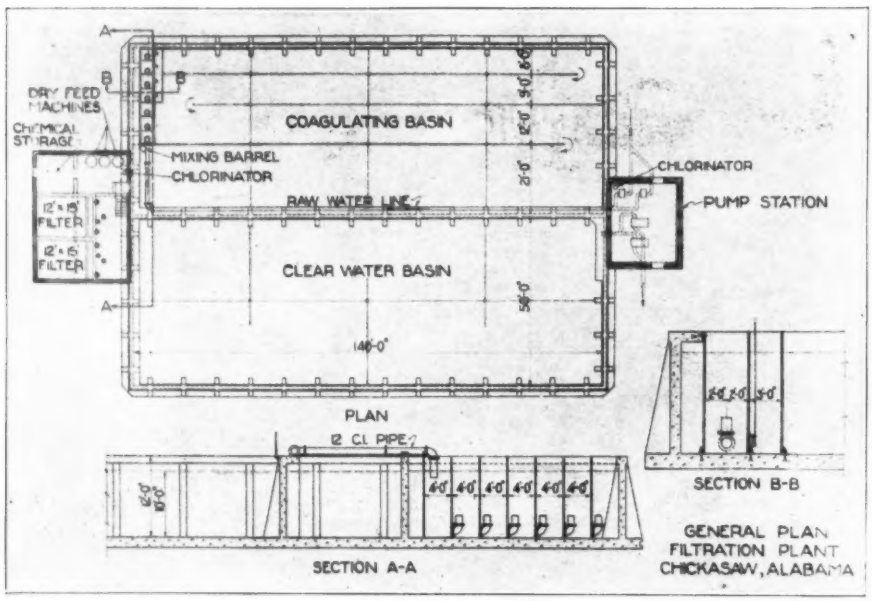
The filtered water showed a pH of 5.9 to 6.1. It was therefore necessary to adjust this value, by the use of lime, to approximately 7.0 to 7.2. It was noted that when the pH was adjusted to 7.4, the appearance of the water was slightly impaired. The alkalinity of the finally treated water was 7 or 8 p.p.m In the design of the plant, provision had been made for introducing lime at various points in the last bay of the coagulating basin. During the experimental operation of the plant, the lime was introduced into the clear water well immediately adjacent to the filter effluent pipes, and into the last bay of the coagulating basin approximately 50 ft. from the filters and 130 ft. from the filters. The final quality of the water was not as satisfactory when lime was introduced into the coagulating basin as that obtained when the lime was introduced into the clear water well. Although there was a very slight increase in the color when lime was introduced into the clear water well, this increase was not as great as when the lime was introduced into the coagulating basin. At times, since the plant was placed in operation, suffi-

from a dry feed machine or mixed into solution in a tank and fed through orifice boxes. As the function of the chlorine is to oxidize the ferrous iron before it reaches the raw water, it is essential that extreme care be exercised in designing apparatus which will secure this result continuously. Complete oxidation of the ferrous iron is essential and therefore frequent tests should be made during the operation of the plant to determine that this result is being obtained. It cannot be emphasized too strongly that it is far preferable to operate on the side of safety and always have present an excess of chlorine rather than to, at any time, introduce into the coagulating basin a solution which has not been completely oxidized.

Application of Chlorinated-Copperas.—When it had been definitely determined that "chlorinated-copperas"



Coagulating Basin, Clear Well and Filter Building



General Plan of Filtration Plant of Chickasaw Utilities Co. at Chickasaw, Ala.

cient lime to increase the pH to 8.0 has been used without seriously increasing the color. The coagulating basin is divided into four bays by three round-the-end baffles. These baffles are so set as to produce theoretical velocities varying from 1.165 ft. per minute in the first bay to 0.445 ft. per minute in the fourth bay. This arrangement effects a more even distribution of the sludge. However, the greatest volume of sludge is precipitated in the first bay.

Advantages.—Compared to other processes of coagulation, it was found that this process was efficient and economical, while introducing no difficult problems in operation. The saving in cost of chemicals, as compared with that of other processes tried, was found to be approximately $10 per million gallons. A further economy resulting from the use of "chlorinated-copperas," as compared to alum and lime, is the increased length of filter runs which is sufficient to effect a saving of 50 per cent or more in wash water required.

Experimental work done recently by Mr. John R. Baylis on Lake Michigan water at Chicago has indicated that "chlorinated-copperas" and aluminum sulphate were required in ratios varying from 3 to 5 in winter when the water was cold to 1 to 3 in summer when the water was warm; that is, "chlorinated-copperas" was about three times as effective as aluminum sulphate. Baylis also points out that in addition to being cheaper, another advantage of ferric salts over aluminum sulphate in many waters is the wide pH range over which precipitation may take place.

These advantages indicate that "chlorinated-copperas" will, in the future, be used more extensively in order to combine economy, efficiency, ease of operation, and flexibility in the matter of securing coagulation over a wide pH range.

Acknowledgment.—The foregoing is an abstract of a paper read before the Southeastern Section of the American Water Works Associaton at the annual meeting, held at Savannah, Ga., April 15, 16 and 17, 1930.

Prominent Engineers of the World Receive Medals

Sixteen of the foremost engineers of the world from as many countries described the influence of engineering upon the life of the people in their parts of the world as a part of the 50th Anniversary Celebration of the American Society of Mechanical Engineers.

The papers also visualized the future of engineering in the promotion of the welfare of the people. The authors were awarded the Fiftieth Anniversary Medal by ambassadors of their respective nations, resident in Washington.

Julio Kilenyi, portrait sculptor, is the designer of the medal. He has designed many medals, including the John J. Pershing medallion, the President Coolidge inaugural medal, the Charles A. Lindberg medal and the Thomas A. Edison medal for Edison Pioneers. This recent creation symbolizes the engineer and his past and present achievements.

The United States was represented among the sixteen by Dr. C. E. Grunsky, president of the American Engineering Council, and Great Britain by Loughman St. L. Penred, editor of "The Engineer." Other countries and their representatives were: Canada, Brigadier General C. H. Mitchell, dean of the faculty of applied science of the University of Toronto; Germany, Dr. Ing. Conrad Matschoss; France, Georges Claude; Japan, Dr. Masawo Kamo, of the Tokyo Imperial University; and Italy, Senator Luigi Luiggi.

South America's representatives were Prof. Donato Gaminara, of Uruguay, a member of the Pan-American highway commission, and Prof. Julio Garzon Nieto, a chief engineer with the Colombian government. From Austria, Hofrat Ing. L. Erhard, director of Technisches Museum, Vienna, came; from Belgium, Monsieur le Baron Gaston de Bethune, representing six eminent engineers; from Netherlands, Prof Ir. D. Dresden; from Scandinavia, Vilhelm Nordstrom, of Stockholm, Sweden; and from Switzerland, Prof. Dr. Aurel Stodola, a professor at the federal technical high school in Zurich. Mexico also was represented.

Power from Volcanic Steam

In Larderello, a region near Pisa, in Italy, volcanic steam springs up from crevices in the ground. If steel pipes, some 10 in. in diameter, are sunk from 150 to 200 ft. into the ground, steam at 5 to 6 lb. atmospheric pressure spurts up, and if properly collected by other steam pipes and reservoirs, a regular supply can be utilized for driving steam engines. The first experiments were made about 1916-17 with a 50-hp. steam engine. It worked perfectly for months. Then the idea of making a real serious industrial experiment was realized in a plant of three 5,000-hp. steam turbines, connected with three dynamos. The experiment was most successful and has been working regularly up to now. The electrical energy is distributed to the small cities in Tuscany for illumination. Thus even volcanic steam is being employed to solve the lack of fuel problem in Italy.

Reforestation by Hackensack Water Co.

Experimental reforestation started twelve years ago by Robert W. De Forest, in Bergen County, New Jersey, is developing forested areas as an instrument of sanitary control. In the uplands surrounding Oradell Lake, one of the storage reservoirs of the Hackensack Water Co., of which Mr. De Forest was then president, and of which he is now chairman of the board, pine groves are rapidly taking shape to afford protection from contamination and erosion.

Many acres of splendid pines are flourishing in Haworth, Harrington Park, and Emerson. Mr. De Forest's reforestation policy is being continued under his successor, Nicholas S. Hill, Jr., of New York, who announces that in the Spring further experimental planting will be carried out in the area created by dredging the Hackensack River and its tributaries at the north end of Oradell Lake for water purification and operation purposes.

This area, traversed by some highways carrying heavy motor traffic, is more than five miles long and about half a mile wide. It comprises large expanses of water and long flat winding islands.

In co-operation with the Mosquito Commission, the water company is assuming control of drainage problems and is thus improving sanitary conditions in the areas tributary to the Hackensack River.

Weeping willows, elms, and sweet gums will be planted in the low spots which are no longer swampy. On higher ground, masses of white birch will be set out, while near roads, there will be plantings of red, white and Scotch pines from the Water Company nurseries.

Oradell Lake is one of the largest artificially dredged reservoirs in the country, and in its construction several million cubic yards of excavated material was deposited in wide areas surrounding the shore line. Much of this material was pure sand and seemingly unsuitable to the growth of trees. Yet certain varieties of pines literally thrive in such surroundings. The reason is that this excavated sand contains a great deal of humus, and presents a surface that acts as a mulch to conserve the moisture below, George R. Spalding, sanitary engineer of the company, explains.

Numerous kinds of pine trees, each adapted to the character of the soil, are utilized in the various plantings fostered by Mr. De Forest in the belief that all of the territory immediately adjacent to the reservoir should be both protected and adorned. These pines consist principally of long lived varities such as Norwegian Red Pine and native American Pine, which keep their beauty and attain great age and size.

Water Works and Sewerage

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Active Water Taps as Indexes of Population

The number of active taps, or of meters where universal meterage exists, is the best index of city population in America. Each city, however, has its own ratio of population to taps, but as this ratio changes very slowly, and in a way that can usually be estimated quite accurately, it becomes possible to determine its population with great accuracy.

We suggest to the heads of all water departments and companies that the ratio of population to active taps be calculated now and compared with the corresponding ratio 10 years ago, and that the rate at which that ratio has changed be determined. Then, guided by these data, an accurate estimate of population can be made each year until the next census 10 years hence. The resulting calculations should be published in the annual reports, for it is often difficult to ascertain what was the number of active taps at a given time in the past.

In a town where many of the inhabitants still secure their water from wells, a count should be made of the wells, once a year, so that allowance can be made for any increase in active taps that does not result in an increase in population.

The total number of taps is a less significant figure than the number of active taps, especially in a town that is not growing rapidly, for obviously an unused tap is not a measure of population. Of course, where the number of idle service pipes is a constant percentage of the total number, no error would result from estimating the population on the basis of the total number.

Chambers of Commerce are accustomed to estimate city populations in several ways. The number of school children, the number of registered voters, the number of telephone users, the number of names in city directories, and some other indexes of population are commonly used. The birth rate is declining, while the number of years that the average child remains in school is increasing, hence school registration is not a very reliable criterion of population. Registered voters are notoriously unreliable. City directories have all but vanished since most of the residents of cities have become telephone users whose addresses can be found in telephone directories.

In passing, we may add that the telephone companies are usually better informed as to the population of each city than is the Chamber of Commerce or any other private corporation or association. Of all the public sources of information as to population, none is equal to the water department of a city in its ability to give an accurate estimate of population. If, then, the water department would cooperate with the telephone company, by comparing their population estimates once a year, no serious error would ever creep into the estimates of population.

Cries of dismay have recently arisen from hundreds of Chambers of Commerce over the populations disclosed by the census. Many recounts have been demanded, and all because unreliable criteria of population have been used by Chambers of Commerce.

At no great expense the U. S. Census could be kept up to date for every city and town in America by adopting the method above outlined, and there would then be no disappointments when the results of the decennial census count were published. Moreover, city engineers, water superintendents and other who plan water works and sewerage systems and extensions would always have reliable population data upon which to base their plans not only for each city as a whole but for each section of the city.

The telephone engineers design underground conduits to take care of population growth at least 10 years ahead. To do this with accuracy they must know the rate of growth of each section of the city. It is not sufficient to know that the growth of the city as a whole is, say, 20 per cent in 10 years. They must know its rate of growth in its different sections; for if one section is growing at the rate of 30 per cent, while another is growing at the rate of 5 per cent per decade, much larger conduits should be be built in the one than in the other section to provide for future population. The same holds true of water mains and sewers. Hence it is not merely a matter of curiosity, but a matter of economy, that prompts the keeping of accurate records of population growth in every part of every city.

The Alleged Profiteering of Electric Companies

With the periodicity of a sunspot cycle comes the discovery that electricty retails at 10 to 15 times its generating cost. The discoverer is usually a politician who immediately broadcasts his discovery, at the same time charging the power companies with profiteering. If such charges were true it would follow that all public service commissions are either derelict in their duty or are in collusion with the power companies.

The fact is that the main cost of electricity sold at retail is the cost of transporting it. In that respect it resembles sand or gravel which cost, say, 10 ct. a cubic yard loaded in the truck and $1 delivered to the builder of a house several miles away from the pit. A more closely analogous case is the cost of water pumped from a lake and delivered through pipes to domestic consumers. The cost of pumping the water is, say, 1 ct. per 1,000 gal., but the entire cost of the delivered water is, say, 10 ct. per 1,000 gal., including interest, depreciation and operating expenses.

An electric generator is really a pump, and it pumps electrons along the conducting wires. The electrons flow through the wires, like water through a pipe, and

their energy is put to use by the retail purchaser of the "juice." He pays, let us say, 8 ct. per kilowatt-hour for the current. This is equivalent to 6 ct. per horsepower-hour. Hence he buys the service of a powerful horse at the rate of 48 ct. for an 8-hour day. A horsepower is fully 8 man-power, hence he buys the equivalent of the services of a very muscular man for 6 ct. a day. It is as if he were hiring a strong man to do household or farm work at 6 ct. a day. Since he could not ordinarily hire a flesh and blood man in America for less than $3 a day, the services of this electrical equivalent of a man-power cost one-fiftieth as much.

Yet there are not a few politicians who try to stir up public animosity against the electric power companies that have made this amazingly cheap power available to more than three-fourths of the families in America. Such politicians completely ignore the fact that electric power has practically eliminated "the servant problem" in American homes.

All the heavy household work, from washing to sweeping, can now be done, and usually is done, by machines driven by electricity. Sewing machines, vacuum cleaners, clothes wringers, refrigerators, fans, radios, and many other devices are run by the electrons that are on tap at any moment of the day or night, and always ready to work at a wage of less than a cent an hour per man-power.

No country in the world uses as much electric power as America uses. None can match us in the variety of domestic and industrial uses that we have devised for electricity. The municipally owned electric plants of Great Britain lag far behind American power plants in per capita sales of "juice." Yet an intelligent man like Ambassador Frederic M. Sackett sees injustice in charging 15 times as much for current at the consumer's premises as it costs to generate it many miles away. Fixed charges on transmission lines, distribution lines, transformers, services, meters, meter-reading, accounting, billing and all other office expenses incurred in selling a mere dab of electricity to each domestic consumer, mean nothing to such a critic, for he knows next to nothing about them.

Einstein Space

In recent lectures Einstein has indicated his belief that "space" is primary and that all else is secondary. Space will have to be regarded as primary and matter derived from it as a secondary result. * * * Space has swallowed up the ether and time, and is about to swallow up the field and corpuscular theory too, so that space will remain as the only theory representing reality. * * * Space is changeable and can be influenced. It is analogous in structure to the electromagnetic field." And he goes on to add that time and space could not be known were there no bodies, which is undoubtedly true but apparently not in accord with his statement that space is the only reality.

Since we have no means of measuring dimensions save by the aid of matter, and since dimension is an essential spatial attribute, well may it be asked how space can "swallow up matter," as Einstein puts it.

It seems to us that Einstein has adopted the essential qualities of ether and has rechristened the aggregate space. Ether was conceived by Faraday and Maxwell as a material that conveys radiant energy and serves as a "field" for the operation of electric and magnetic forces. Einstein's space is made to serve these same functions, but he strives to divest it of materiality, while at the same time stating that it possesses the basic attributes of matter, namely energy, inertia and gravitative power. As between Maxwell's conception of ether and Einstein's conception of space, the former enjoys the distinct advantage of having led to many important discoveries. Not one of Einstein's discoveries has sprung from any thing new in his theory of space. His entire theory of relativity is just as tenable under Maxwell's ether theory as under Einstein's space theory. Indeed two of Einstein's three basic formulas were first deduced by Lorentz, who used an electrodynamic theory, namely the formulas for relative length and relative time. Einstein went a step farther and deduced a formula that shows the convertibility of mass and energy—a truly marvelous deduction, but one not in the slightest degree dependent upon his peculiar theory of space.

In so far as Einstein's theory of space is comprehensible, it bears a striking resemblance to the ether theory. In both theories it is recognized that radiant energy exists in regions apparently not occupied by ordinary matter. This radiant energy, however, has two fundamental properties of matter. It has inertia and it gravitates. The proponents of the ether theory urge that since radiant energy in space discloses those two fundamental properties of matter, some sort of thing like matter occupies all space, and they call it ether. The Einsteinists insist that radiant energy may exist in the absence of anything like matter, and they designate the medium or field where radiant energy exists as space.

At bottom, then, the question is whether radiant waves can exist where there is no matter to wave. The ether advocates insist that they can not conceive a wave where no substance exists. The Einsteinists insist that it is of no consequence whether that can be conceived or not; and that it is simpler to regard radiant waves as existing in a space that has no materiality whatsoever. We confess to a strong preference for the ether theory. Moreover we believe that a logic that abandons conception, or "mental picturing," as a criterion of possible truth is unsound. Certainly all scientific progress thus far has resulted from mental picturing, usually based on analogy. Even Einstein's theory of space is one in which space is regarded as like matter; and only in so far as that analogy has been used by him has he made any discoveries. Einstein's space teems with energy, and every unit in which he measures that energy is a material unit. His "clocks," his "yard sticks" and his "scales," by which he times, measures and weighs, are all material things. Let it be granted that the ticking of clocks varies, that yardsticks change their length, and that scales weigh differently, depending upon their relative velocity. What of it? We have simply learned that no unit of matter is independent of other units, and that all are parts of a vast complex that pervades the universe. And this is true whether that all-pervading complex be called ether or space.

Thus far no discovery has been made by denying that this all-pervading thing is a material thing, whereas almost the entire science of radiant energy has been developed by men who were guided by the ether theory. It will take a deal of discovery based on Einstein's peculiar space to warrant scientists in proclaiming that king ether is dead—long live king space.

H. P. Gillette

Cold Weather Troubles in Filtration

Experiences at the Water Purification Plant of Lawrence, Kan., in the Application of Chlorine and Lime at Low Temperatures

By C. T. HOUGH

Water Superintendent, Lawrence, Kan.

CLOSE observation in the operation of a water purification plant continually presents new problems to the water superintendent. Many times these problems are never overcome without considerable cost, and at times no solution seems possible.

General Details of Supply.—The city of Lawrence obtains its water supply from the Kaw River. The treatment includes plain settling, coagulation, softening, chlorination and filtration. During the year the alkalinity of the raw water varies from 125 p.p.m. in the summer season to 300 p.p.m. in winter. The sulphate hardness is 60 p.p.m. to 125 p.p.m. during these seasons respectively. It is therefore apparent that with a maximum total hardness of 425 p.p.m. a considerable amount of lime must be used to bring about a reduction of some 200 p.p.m. during the winter season.

At low temperatures the reaction of lime in cold water is slow, and this slow reaction produces an effect of reduced retention period in the basins. A large quantity of the precipitated calcium carbonates are unable to settle out and are carried over onto the roughing filters which receive the lime basin effluent. A dosage of 0.7 gr. per gallon of aluminum sulphate is therefore applied to the lime basin influent to assist in settling this precipitate and decrease the roughing filter load. Even though aluminum sulphate is applied, the settling is not complete and a large amount of wash water is required to keep the roughing filters in good condition.

Softening Treatment in Cold Weather.—During the past two years an attempt has been made to maintain the total hardness of the treated water below 125 p.p.m. This is easily possible during the summer months, but during the winter the extent of softening treatment depends upon the amount of normal carbonates in the filter influent. From best authority we know that the normal carbonates in the water should not exceed 16 to 20 p.p.m. for proper filter operation. During the summer months the alkalinity may be carried as low as 40 p.p.m. with normal carbonates at 16 p.p.m. During the winter months the alkalinity cannot be carried below 80 p.p.m. An attempt to carry the alkalinity to 50 p.p.m. at various times during low temperatures has resulted in excessive high normal carbonates and a heavy precipitate on the final filters. An analysis of this precipitate or filter sludge shows that nearly 50 per cent of the sample contained aluminum hydroxide, the remainder consisting of calcium and magnesium carbonates. This precipitate is therefore probably due to the retarded reaction of the aluminum sulphate in the presence of a highly lime treated water. The reduction of the lime treatment, thereby increasing the alkalinity to 70-80 p.p.m. eliminates a large percentage of the precipitates and permits satisfactory filter operation.

Increasing Contact Period for Chlorination.—In September, 1926, a bacteriological laboratory was installed at the plant and daily routine analysis begun. In December of that year these daily analyses of the treated water began to show positive tests of the coli-aerogenes group. The chlorine dosage was increased daily, but without favorable results. It was soon learned that this condition had occurred in the past and various attempts had been made to overcome the trouble. Up to this time the chlorine had been applied to the clear well effluent as the piping was not arranged for chlorination of the effluent from the filters. The chlorine treatment appeared to have no effect irrespective of the quantity applied and it was at once apparent that here was another "cold weather trouble." Samples were taken every four blocks along one main feeder to the city and these samples analyzed. It was found that all samples were positive along the first 1½ miles from the plant, and beyond this point they were negative. These results indicated that the reaction of chlorine in water having a temperature of 38 to 40° F. was slow, and that the chlorine must have a sufficient contact period before the water is pumped to the city. An additional chlorinator was immediately procured, and a chlorine dosage first applied at the filter influent. The results were better, but the trouble still existed. The chlorine dosage was then applied at the lime basin influent, allowing more retention period and the bacterial tests at once showed negative results. With the double chlorination method, the total quantity of chlorine applied was not increased. About 2½ lb. of chlorine per 1,000,000 gal. was applied at the lime basin influent and 2 lb. to the suction of the high service pumps. It is believed that very little benefit is obtained from the second chlorine dosage, however this second dosage is added for additional protection.

Further operation with double chlorination has proven that the effect of chlorine in cold water not only depends upon a sufficient contact period, but that the pH value, or the extent to which the softening process is carried also depends upon the bacterial quality. During the past three months softening has not been carried to such an extent as in former years. The alkalinity of the treated water has been maintained between the limits of 100 to 150 p.p.m. The temperature of the treated water at the plant during this time has been 37 to 40° F. Daily bacterial analyses have brought continual negative results. Recent attempts to increase the lime dosage to give an alkalinity of 60 to 70 p.p.m. caused positive bacterial tests immediately. This condition was no different than in past years and was accompanied with the usual increased precipitate on the filters. These positive results however do not remain permanent. Samples taken along the main feeder lines some distance from the plant have had sufficient time for the chlorine to react, and analyses of samples taken on the tap daily at the State Board of Health laboratories are negative. It is evident therefor that increasing the pH value of the treated water decreases the effectiveness of chlorine.

In conclusion it may be stated that no attempts have been made to conduct a series of tests on these conditions through the usual plant operation, for we do not wish to jeopardize the rating of the bacterial quality of the water either with the consumer or the State Board of Health. From this experience, however, the following conclusions are evident: That ample retention period should be considered in the design of settling basins for the application of chlorine and also for softening treatment for water at low temperatures. That better results will be obtained by double chlorination or by the application of chlorine prior to the application of lime. That the effectiveness of chlorine depends upon both the contact period as well as the pH value of the water at low temperatures.

Acknowledgment.—The foregoing is a paper presented at the 8th annual Three Day School of the University of Kansas and the 5th annual meeting of the Kansas Water Works Association.

DISTRIBUTOR NEWS

The Distributor's Department in the Gillette Construction Group

Strike Up the Band

The Manistee Iron Works believes that a band is not only good to produce harmony of sound but is likewise good for effecting harmony of effort and understanding. For this reason, when the band was organized about a year and a half ago, the officers of the company gave to the enterprise wholehearted moral and financial support. The company now boasts of a band in which each department of the plant and office is represented.

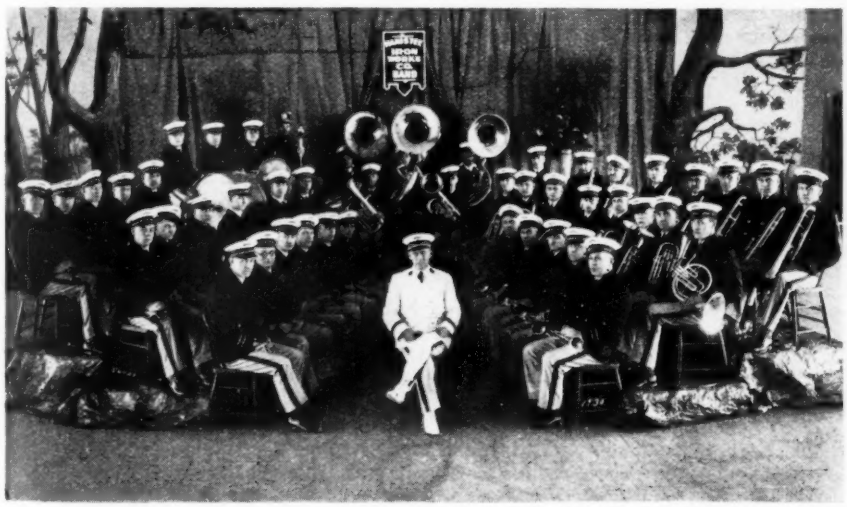
The band lists on its membership roll executives of the company, clerks, draftsmen, foremen and mechanics. The handsome uniforms resemble those of the Marine Corps, and because this is one of the largest industrial bands in the state of Michigan, and is the only one in the section of the country near Manistee, it is in great demand in its own town and in neighboring cities.

Although this musical organization is still quite young it has given a number of concerts, and, it is said, that the programs are selected with great care in order to meet the tastes of the listeners, and standard music with a wide variety of appeal is presented. Most of the band members own their own instruments, which are all of standard makes.

The Manistee Company takes a very just pride in this organization activity, and in referring to its formation, Mr. J. R. Ray, the president of the Manistee Iron Works Company, said: "We were fortunate in having quite a number of musicians in our employ, but as we thought a fairly large band was wanted, it was necessary to take in some who had no musical knowledge or experience. The different musicians of the band, however, volunteered their services and taught these beginners, and by dint of much intensive study and practice they have accomplished truly remarkable results."

Mr. Ray states that the company is favorably disposed towards activities of this nature because they do much to promote a healthy shop spirit and a better understanding between the different departments which can be accomplished in no other way. In addition to the band, the company boasts of baseball and basket-ball teams, both of which have records of successful seasons to their credit.

Editor's Note: Why wouldn't the attendance of some of the good industrial bands of the country at a few of the annual conventions do much to increase the attendance at conferences and program meetings?



ROSTER OF MANISTEE IRON WORKS COMPANY BAND, MANISTEE, MICH.

Band Officers: President, H. R. Ray; Vice-President, R. S. Topping; Secretary, J. D. Mish; Treasurer, Felix Johnson; Librarian, A. A. Mish. Personnel: Director, C. W. O'Donnell; Cornets, Stanley O'Donnell, David Kliber, Walter Gehrke, Harvey Ray, Frank Baker; Trombones, John Mish, Al Mish, Ray Ahlgren, Jack Leet, Louis Johnson, George Rydback, Lewis Daniels; Altos, Felix Johnson, Golden Eckholm, Norman Dewar, Gordon Radtke, Leslie Hummell, Ernest Jaekel, Richard Kylberg, Oscar Anderson; Drums, Elmer Ness, John O'Donnell, Gerald Mann; Clarinets, E. Gunderson, Chas. Hansen, Tony Raskey, Norman Chambers, Clarence Carlson, Casmir Pacholski, Al Anderson, Gerald Nott, I. Abrahamson, M. Jankowski, A. Mausolf, Rex Mix, Leo Pacholski, Ed Nowak, Austin Pehrson, Arthur Mason; Piccolo, Pat Thompson; Baritones, Robert Topping, Harlem Ray; Tenor, George Galvas; Basses, Carl Hedstrom, Clarence Kieft, Edward Hanson; Drum Major, Robert Bremer.

Peerless Pump Company Anticipates Big Year

Mr. E. M. Smith, chairman of the board of the Peerless Pump Company, states that their sales for this year already show a substantial increase over the corresponding period for last year, and he believes 1930 will prove a banner year for his company.

An expansion program has been inaugurated by Peerless to care for the increasing demand for their products, which includes the opening of a branch factory, and the appointment of several new representatives in various parts of the world. It is reported that the South American business of this company during the past eighteen months has exceeded $300,000.

The latest addition to the Peerless line is the completely protected Moturbo type pump head, sales of which, according to report, have greatly exceeded the estimates made for it.

Brown Instrument Company to Increase Plant

Owing to the continued growth of the demand for the products of the Brown Instrument Company of Philadelphia, contract has been let to Robert E. Lamb Company for 40,000 sq. ft. of additional floor space. Mechanical and electrical equipment will be installed under separate contracts with local concerns, according to recent report. This is the third successive year in which the company has been obliged to expand to meet their business requirements.

The new plans call for two additional floors on the new two-story concrete sections of the plant. Working plans are said to have been prepared by the Ballinger Company of Philadelphia, under the supervision of W. E. Camp, industrial engineer of the Brown Company. The company expects to occupy the new space in the early fall.

Indicating, recording and controlling instruments for industrial purposes, including pyrometers, flow meters and thermometers are included in the products of the Brown Company.

A Correction

An error occurred in the Who's Who Picture Gallery presented in the June issue of *Water Works & Sewerage* which we very much regret. The titles appearing under the names of Mr. Walter J. O'Day and Mr. Frank J. Egan, both identified with the cast iron pipe and foundry department of

WALTER J. O'DAY
Manager, Chicago
Cast Iron Pipe & Fdry. Dept.
James B. Clow & Sons

James B. Clow & Sons were transposed, the title belonging to Mr. O'Day appearing under Mr. Egan's name and vice-versa. The error occurred after proofs were read in shifting the various cuts in order to group together the representatives of the Clow company and those of the National Cast Iron Pipe Company.

FRANK J. EGAN
Assistant Manager, Chicago
Cast Iron Pipe & Fdry. Dept.
James B. Clow & Sons

Mr. Walter J. O'Day is manager and Mr. F. J. Egan assistant manager of the cast iron and foundry department of the Clow organization.

No Grief Here!

A report of 271 per cent increase in sales for the first five months of the present year over the same period for last year is the good news just received concerning the business of Tube-Turns, Incorporated, of Louisville, Ky., as announced by Mr. Walter H. Girdler, president of the Girdler Corporation, which operates the former company.

Tube-Turns are seamless forged, short-radius, uniform wall fittings for pipe welding, and Mr. Girdler states that for some time the plant has been operating twenty-four hours a day, six days a week, and due to the greatly increased business an expansion of facilities has been made necessary. Expansion now under way will allow for an additional production of 60 per cent, according to report of the president. Addition to the plant will be ready for use July 1, and the new equipment will be in operation Aug. 1.

This company maintains a chain of forty-four distributors and branches in this and other countries, and Mr. E. H. Courtenay, vice-president and director of sales, reports markets for their product in Hawaii, Canada, Central and South America.

Lukens Steel Company Forms Subsidiary

Announcement is made by Robert W. Wolcott, president of the Lukens Steel Co., of Coatesville, Pa., of the entry of this company into the field of supplying welded construction to the manufacturers of machinery and equipment. Research and development work in this connection has been going forward for several months and approximately 50,000 sq. ft. of manufacturing space has been provided at the Coatesville plant for this activity.

Operations in this field will be carried on through a subsidiary company known as Lukenweld, Incorporated, which for the present will utilize some of the manufacturing facilities of the parent company.

Mr. Wolcott states that rapidly increasing demand on the part of machinery and equipment buyers for welded steel construction is responsible for the new development. An extensive program of development and research work has been laid out to assure the safety and economy of welded steel design. They are prepared to furnish engineering assistance to users of this class of construction through a development and research division.

The new company has twenty-four operators working at the present time and expects to have fifty in production within the next sixty days.

Mr. G. D. Spackman is president of Lukenweld, Incorported.

New Distributor for Hercules Engines

The Hercules Motors Corporation of Canton, Ohio, announces the appointment of new distributors in various sections of the United States who will handle Hercules engines, power units and parts.

The new distributors are the F. C. Richmond Company, Salt Lake City, Utah, as exclusive distributor for the Mountain States; Worthington Machinery Corporation of Oklahoma, Tulsa, Okla., exclusive distributor for Oklahoma and adjacent territory; and Alamo Iron Works of San Antonio, Texas, who will sell Hercules engines and parts in the Winter Garden section of Texas. Each of these firms will carry a representative stock of engines and power units, together with a complete supply of parts for engines in service.

With the Smith-Booth-Usher Company of Los Angeles, Calif.; Edward R. Bacon of San Francisco, Calif.; the Norvell-Wilder Hardware Company of Houston, Texas, and Boviard & Company of Bradford, Penna., distributors for their respective territories, Hercules customers are now assured prompt and efficient sales and parts service in the far West, in the Mid-Continent and in the Pennsylvania oil fields.

In addition to the new representatives of Hercules in this country the manufacturer is extending the distribution of products in Europe. Announcement is made of the appointment of the Automotive Products Company, 3 Berners Street, London, W. 1., as sales distributors for Great Britain and the Continent. This distributing company maintains branch offices at Berlin (Zollernhof, 56 Unter den Linden), and at Vienna (1—Lobkowitzplatz).

It is stated by the manufacturers that the sale of Hercules will be pushed in the European market not only for commercial vehicles, but for use on general industrial equipment, agricultural and oil producing machinery of European make.

Paradon Manufacturing Company, Arlington, N. J., announces that Mr. M. B. Urquhart, 509 17th St., Denver, who is in charge of sales and service of chlorinators in the state of Colorado, has had his territory expanded to include Utah, Wyoming and New Mexico. Mr. Urquhart has just completed a month's visit to the factory at Arlington.

The Filtration Equipment Corporation announces the opening of its general offices in the Borden Building, 350 Madison Avenue, New York. Mr. W. C. Laughlin is president of this organization, which will serve the field of industrial and municipal sanitary engineering, specializing in processes and equipment for the economical removal of solids from liquids.

Aeroil Burner Company, Inc., whose headquarters are located in West New York, N. J., announces the opening of a Pacific Coast office and warehouse at 469 Bryant St., San Francisco, Calif., in charge of Mr. R. M. Starner.

Paradon Manufacturing Company announces the appointment of Mr. George Bird as assistant manager of sales, with headquarters at Arlington, N. J. Mr. Bird was formerly engaged in field sales and service work for this company.

THE MOST IMPORTANT INGREDIENT IN YOUR PIPE COATING IS

EXPERIENCE

The best solution to any of the problems that come up in the business of coating pipes is knowledge. Robertson has the knowledge. The H. H. Robertson Co. is the world's largest producer of special asphalts. It has made investigations in the action of soils on coating materials. It can determine the exact combination of asphaltic bases that are best calculated to protect your pipe under any given set of conditions . . . and it can produce exactly that combination.

Specify Robertson coatings on your pipes.

H. H. ROBERTSON CO.,
PITTSBURGH, PA.

ROBERTSON HAS THE EXPERIENCE

WATER CONTROL . . .

Without Floats or Fixtures

A constant level can be automatically maintained in reservoirs, tanks and standpipes by the use of

GOLDEN-ANDERSON Automatic "Cushioned" Controlling Altitude Valves

These valves are always cushioned in closing and opening. They are extensively used for automatically maintaining a uniform stage of water in reservoirs, tanks and standpipes. No valves inside. No floats or fixtures, inside or outside of tanks. No freezing troubles. Three ways of closing these valves:
1st—Automatically, by water.
2nd—By electricity, if desired.
3rd—By hand.

Remember: **Valves cushioned at all times by air and water. No water hammer or bursting mains.**

"Made with stop starter attachment for centrifugal pumps."

GOLDEN-ANDERSON VALVE SPECIALTY CO.
1386 Fulton Bldg., PITTSBURGH, PA.

GOLDEN-ANDERSON

Pat. Cushioned Water Relief Valves

1. Automatically relieve excess pressure.
2. Prevent stress, strain and busting of mains.
3. Correct mechanical construction.
4. Perfect air and water cushioning.
5. No metal-to-metal seats. No hammering or shocks.
6. Angle and globe pattern. Sizes 3 to 24-in.

GOLDEN-ANDERSON

Patent Automatic Cushioned Controlling Float Valves

They carry a constant water level in feed water heaters by perfectly controlling the flow of makeup water.
Operated by protected enclosed copper float.
Cushioned by both air and water.
Operate without hammering, sticking or chattering. No metal-to-metal seats. Made angle or straightway.

Sizes ½ in. to 24 in.

Sizes ½ in. to 24 in.

GOLDEN-ANDERSON

Pat. Automatic Cushioned Water Float Valves

1. Automatically maintain uniform water levels in tanks, standpipes, etc.
2. Instantly adjusted to operate quickly or slowly.
3. Floats swivel to any angle—Most satisfactory float valve known.
4. No metal-to-metal seats—No water hammer or shock.
5. Cushioned by water and air.

GOLDEN-ANDERSON

Pat. Automatic Cushioned Water Pressure Regulating Valves

1. Maintain a constant reduced pressure regardless of fluctuations on high pressure side.
2. Perfectly cushioned by water and air. No metal-to-metal seats.
3. The best valve made for maintaining a constant low pressure where consumption is continuous.
4. Operate quickly or slowly as required—No attention necessary.
5. Positively no hammering or sticking. Sizes to 24 in.

Repauno Plant of duPont de Nemours Celebrates 50th Anniversary

A number of manufacturers in the American manufacturing of dynamite were present at the celebration of the 50th anniversary of the Repauno plant of E. I. duPont de Nemours & Company, held recently at Gibbstown, N. J. The celebration took the form of a company picnic attended by several hundred employees, and addresses were made by Lammot duPont, president of the duPont company; J. W. McCoy, general manager of the high explosives department, and others. P. C. Kaiser, plant manager was master of ceremonies, assisted by H. K. Babbitt, director of the high explosives manufacturing department.

Among those present was Herbert G. Chase, who occupied an executive position at the plant for forty-one years, and who retired nine years ago. Another veteran was H. Frank Young, still in active service after having completed a half century at the Repauno plant.

This plant was originally known as the Repauno Chemical Company, the first president being Lammot duPont, whose son is now president of the duPont Company. Mr. duPont predicted that this plant would become the largest dynamite plant in the United States, a prophecy which has been more than fulfilled, for it is now said to be the largest in the world.

Robert Bosch Truck Carried Renault Racing Car to S.A.E. Meeting

The Robert Bosch Magneto Co., Inc., exhibited and demonstrated its heavy oil engined truck at the summer meeting of the Society of Automotive Engineers, at French Lick, Ind., May 25 to 29. After this meeting this truck was driven to State College, Pennsylvania, for exhibition at the National Oil and Petroleum exhibition, held there June 12 to 14.

Previous to the S.A.E. summer meeting this truck was driven overland to French Lick from New York with a load consisting of the Renault racing car in which Marcel Renault won the Paris-Bordeaux race in 1921.

In addition one of the latest type Maybach-Diesel engines was carried. This was also on exhibition during the meeting.

Standard Road Equipment Announces Changes

At a recent meeting of the board of directors of the Standard Road Equipment Co., Inc., Mr. C. C. Fuller was elected to the office of president to succeed Mr. A. H. Puffer, resigned. It is stated that Mr. Puffer will continue as an active member of the company. Mr. Fuller formerly was connected with W. B. Louer Co. of Chicago.

Sales and service of the Allis-Chalmers Monarch Tractors and the Allis-Chalmers United Industrial Tractors for the northern Illinois counties are now handled by Standard Road Equipment Co. The company announces that a complete stock of repairs and replacement parts is kept in both Chicago and Rockford, and a force of mechanics is available from either point.

Mr. H. B. Faith is another former W. B. Louer Co. representative to join the sales organization of Standard. General offices and warehouse of this company are located at 2724 Auburn St., Rockford, Ill.

A MEETING OF THE CLANS

Maybe "Koehrings" aren't Scotch and this heading should read "A Meeting of the Gangs," but the point is they did meet. Two Milwaukee contractors, with two separate sewer jobs, happened to converge with the result that two pull shovels and five cranes all of the same family origin exchange friendly greetings and view the work of the paver being used for pouring concrete for the sewer forms.

Additional Western Offices for Hercules Motors

Announcement has been made of the appointment of Mr. Walter F. Radtke as Pacific Coast sales representative. Mr. Radtke, who formerly represented Hercules in the mid-continent states, took over his new duties on June 1st. Headquarters have been opened in the Russ Building, San Francisco, Calif.

Another office to be opened by this manufacturer is one at Tulsa, Okla., under the direction of Mr. R. J. Scott. This office will serve the Hercules customers in the mid-continent oil fields. Mr. Scott is located in the Mayo Building.

Announcement

Blaw-Knox International Corporation is the new name for the Export Organization of the Blaw-Knox Company, which was formerly known as Milliken Brothers-Blaw-Knox Corporation, which in turn succeeded the original Milliken Brothers Manufacturing Company.

This change in name is due to the larger scope of the company's activities and thoroughly identifies the Export Company as such. The change of name embraces no change in personnel and the offices will remain as formerly, in the Canadian-Pacific Building, New York City.

Blaw-Knox International Corporation handles all the products of the Blaw-Knox Company including road building equipment, clamshell buckets, central mixing plants, steel bins, measuring batchers, truck turntables, dragline buckets, agitator truck bodies, steel buildings, etc., in South America, the West Indies and other parts of the world where the Blaw-Knox Company is not otherwise represented.

Ash Grove Lime & Cement Takes Larger Quarters

To better accommodate its many patrons, the Ash Grove Lime and Portland Cement Company announces the removal of its general offices. The entire eleventh floor of the Fairfax Building, located at 101 West 11th Street, Kansas City, Mo., has been taken over by this organization.

Official personnel of the Ash Grove Company, which was founded in 1882, includes: L. R. Sunderland, president; J. P. Pollock, vice-president; A. Lundteigen, vice-president; W. P. Sabin, vice-president and treasurer; A. B. Sunderland, secretary and asst. treasurer; W. R. Anderson, sales manager; J. L. Evans, asst. sales manager; G. N. Berry, asst. sales manager; W. S. Barton, traffic manager, and L. Kittle, general auditor.

Continental Motors Corporation announces that schedules have been arranged so that all employes will be given their annual vacations from June 29th to July 14th.

De Laval Pumps
make water supply certain

APPLETON, Wis., is protected at all times by this 2800 gal. per min. De Laval pump, which generates 200 ft. head when driven at 1150 r.p.m. by a Sterling gas engine.

The leading position of De Laval pumps in municipal water supply service is to be attributed to their high power efficiency and first-class, reliable construction.

De Laval Steam Turbine Co.,
Trenton, New Jersey

4019

CUSHIONING CONCRETE HIGHWAYS against the heavy pounding of traffic . . . adding extra years of repair-free smoothness . . . that's the job of Carey Elastite Expansion Joint! Unaffected by extemes of heat or cold! Comes in flexible, preformed strips . . . easy to handle . . . inexpensive. Yes, quick deliveries!

Carey Elastite EXPANSION JOINT

THE PHILIP CAREY COMPANY
Lockland
Cincinnati, Ohio

SERVICE EXCHANGE
For
Manufacturers or Distributors

Editor's Note.—From time to time we receive letters from distributors wishing to be put in touch with manufacturers of certain lines of equipment, or from manufacturers seeking representatives for their products. Items of this kind will be published and names and addresses furnished interested persons upon request.

New Lines Wanted

West Coast distributor, specializing in materials for sewers and water works, is in a position to render splendid representation for territory covered.

Manufacturer's representative, with warehouse facilities available, would like to secure additional lines in water works and sewerage and general contracting fields. Covers Houston and San Antonio territory.

Water Works equipment distributor, covering northeastern Indiana, would like to secure represenation of a line of chlorinators.

Manufacturers' agents representing well known lines of water works equipment desire to secure line of pipe pushers and other similar equipment for California and western Nevada territory.

Distributor covering northern California, having warehouse facilities, would like to secure line of water meters, pipe jacks or pushers, flow meters, and sewage treatment and disposal material and equipment.

Bacteriologist would like to make connection with manufacturer for such work, or as assistant chemist.

Canadian distributor of equipment for water softening, filtration, sewage purification and pumping is interested in securing exclusive sales rights for kindred equipment in the Dominion.

Manufacturer of centrifugal pumps for water works, sewage plants, sand and dredging plants, process industry, contractors, etc., desires to secure additional representation. Attractive territory available.

Manufacturer's representative now handling centrifugal pumps would like to secure other lines in water works field. Covers eastern Pennsylvania, south Jersey and Delaware.

Manufacturer's representative with 25 years sales experience, conversant with all types of pumps and their field, desires agency for either New York or export territory, or both.

Distributor covering New Jersey and New York territory would like to secure a line of street markers or other traffic equipment on exclusive basis.

Equipment distributor in Pacific Northwest desires line of road building equipment, structural building equipment, dump bodies and truck hoists.

Machinery distributor established in Porto Rico and Santo Domingo would be pleased to make arrangements to take on new lines in these territories.

Representatives Wanted

Manufacturer of special valve and hydrant lubricant wishes to establish distributing points throughout the country.

Manufacturer of threadless pipe couplings and tees, with rapidly growing business, is seeking additional representatives.

Manufacturer of non-clogging sewage pumps, both horizontal and vertical, as well as water works pumps suitable for municipalities of 50,000 or 60,000 people, is interested in securing additional sales representation.

Distributors wanted for deep-well turbine pumping unit. Product serves small industrial plants, private estates and farmers.

Manufacturer of water works brass goods would like to make proposition to manufacturers' representatives calling on water works' trade.

District representatives wanted for sanitary engineering specialty used extensively in the water works, sewage and swimming pool fields.

Well established manufacturers' representatives wanted to handle sand and gravel pumps and equipment, in key cities, by successful manufacturer of high grade dredging pumps and hydraulic dredging equipment. Give character of equipment now being handled and territory covered.

Manufacturer of air compressors and contractors' tools has number of desirable territories open. Full co-operation will be extended to distributors.

Manufacturer of contractors and builders levels and transits is seeking district sales manager. Exclusive contract given. Excellent territory still available. Backed by national advertising.

Distributors wanted to represent improved type of snow fence. Good territory in various parts of country.

Hunter Machinery to Represent Trackson Co.

The Trackson Co., Milwaukee, Wis., announces the appointment of the Hunter Machinery Co., 16th St. Viaduct, Milwaukee, Wis., as a new distributor of Trackson tractor equipment.

This company has branches located

Mr. M. R. Hunter

at 221 S. Waterman Ave., Detroit, Mich., and at 530 Monroe Ave., N. W., Grand Rapids, Mich. They will handle Trackson crawlers, shovels, cranes, hoists, etc., and will be able to give prompt service on all orders for machines as well as for repair and replacement parts.

Mr. Morton R. Hunter is president of the company bearing his name.

Sullivan Machinery Company of Chicago, manufacturers of portable and stationary air compressors, rock drills, concrete breakers, portable hoists, drill sharpeners, etc., announce the appointment of the Carolina Contractors Equipment & Supply Company, 824 Lady St., Columbia, S. C., as distributors for their products.

Old Wheeling Firm Announces Merger

The Wheeling Mold Foundry Company, Duquesne Steel Foundry and Hubbard Steel Foundry will in future be operated as Continental Roll & Steel Foundry Company, according to recent information.